106-02403/

Annex to: Publication Number T/837
**Air Quality Monitoring: Lloydminster Area**
2002, 2003 & 2004 Seasonal Monitoring

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In order to address air quality issues identified in the *Lloydminster Area Air Quality Monitoring Report* (Pub No. T/837), Alberta Environment has initiated actions with companies involved in the associated monitoring project.

Since the monitoring was completed, Husky Asphalt Refinery has improved pollution abatement measures (2004-2005) and no odour complaints have been received. On September 30, 2005, the *Environmental Protection and Enhancement Act* approval for the Husky Asphalt Refinery was renewed with conditions that address the implementation of several programs to reduce overall emissions. On October 7, 2005, Husky Asphalt Refinery staff agreed to explore options regarding various hydrogen sulphide monitors and appropriate monitoring locations.

While activities at the Greif Containers site do not require an approval under the *Environmental Protection and Enhancement Act*, they must comply with the general provisions of the Act.

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# Air Quality Monitoring

## Lloydminster Area

## 2002, 2003 & 2004 Seasonal Monitoring — Final Report

Alberta Environment conducts mobile air quality surveys each year as part of its air quality monitoring program. These monitoring surveys are unannounced and use the Department's *Mobile Air Monitoring Laboratory* (MAML). The MAML provides a "snapshot" in time and space of the air quality at the location monitored. Pollutants measured by the MAML included ammonia, carbon monoxide, hydrocarbons, oxides of nitrogen, ozone, particulate matter, reduced sulphur compounds and sulphur dioxide.

In 2002, 2003 and 2004, Alberta Environment conducted a series of ambient air quality monitoring surveys in the Lloydminster Area. Five monitoring locations were selected in consultation with stakeholders and staff from Alberta Environment's Central Region office.

This study consisted of eight seasons of monitoring using the MAML's suite of analyzers; canister samples were also collected during these surveys for later laboratory analyses of volatile organic compounds. The MAML monitored air quality for 124 hours in the Lloydminster area. The objectives of monitoring this area were:

(1) to address odour complaints,

(2) to identify and determine the concentrations of air pollutants near industrial facilities in the survey area, and

(3) to support ongoing work of Regional compliance and approvals staff.

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Each location was monitored for a minimum of one hour to allow comparison with applicable one-hour Alberta Ambient Air Quality Objectives (AAAQO). Results from other mobile surveys and 2004 data from permanent monitoring stations in Alberta are also presented in this report for comparison purposes.

Elevated reactive hydrocarbon concentrations were measured at the Greif Containers site and elevated reduced sulphur compounds were measured at the Husky Refinery. Hydrogen sulphide exceeded its one-hour AAAQO a total of eight times at two of the monitoring locations. Ambient concentrations of all other air pollutants measured by the MAML, as well as those measured through canister analyses, were below applicable AAAQOs.

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(1) With the exception of hydrogen sulphide, concentrations of air pollutants measured in the Lloydminster Area survey were below Alberta's Ambient Air Quality Objectives (AAAQO). Alberta has one-hour air quality objectives for ammonia, carbon monoxide, nitrogen dioxide, ozone, hydrogen sulphide and sulphur dioxide. Findings from the survey and the Ambient Air Quality Objectives can be found in Table 1.

**Table 1: Summary of MAML Monitoring results for the Lloydminster Survey.**

| Pollutant | Units | AAAQO | Minimum | Median | Maximum | Number of Exceedances |
|---|---|---|---|---|---|---|
| Ammonia **($NH_3$)** | ppm | 2 | bd | 0.001 | 0.016 | 0 |
| Carbon Monoxide **(CO)** | ppm | 13 | bd | 0.2 | 0.8 | 0 |
| *Hydrocarbons* – Methane **($CH_4$)** | ppm | n/a | 1.6 | 2.2 | 4.9 | -- |
| *Hydrocarbons* – Reactive Hydrocarbons **(RHC)** | ppm | n/a | bd | 0.2 | 2.9 | -- |
| *Hydrocarbons* – Total Hydrocarbons **(THC)** | ppm | n/a | 1.8 | 2.5 | 5.2 | -- |
| *Hydrocarbons* – Polycyclic Aromatic Hydrocarbons **(PAH)** | $ng/m^3$ | n/a | bd | 3 | 27 | -- |
| Nitrogen dioxide **($NO_2$)** | ppm | 0.212 | bd | 0.006 | 0.038 | 0 |
| Nitric Oxide **(NO)** | ppm | n/a | bd | 0.006 | 0.038 | -- |
| Oxides of nitrogen **($NO_x$)** | ppm | n/a | bd | 0.013 | 0.062 | -- |
| Ozone **($O_3$)** | ppm | 0.082 | bd | 0.030 | 0.043 | 0 |
| *Particulates* – Total Suspended Particulates **(TSP)** | $\mu g/m^3$ | n/a | 1 | 19 | 1418 | -- |
| *Particulates* – Particulate Matter <10µm **($PM_{10}$)** | $\mu g/m^3$ | n/a | 1 | 13 | 946 | -- |
| *Particulates* – Particulate Matter <2.5µm **($PM_{2.5}$)** | $\mu g/m^3$ | n/a | bd | 2 | 151 | -- |
| *Sulphur Compounds* - Hydrogen Sulphide **($H_2S$)** | ppm | 0.010 | bd | bd | 0.020 | 8 |
| *Sulphur Compounds* - Total Reduced Sulphur **(TRS)** | ppm | n/a | bd | 0.001 | 0.022 | -- |
| Sulphur Dioxide **($SO_2$)** | ppm | 0.172 | bd | 0.001 | 0.023 | 0 |

$\mu g/m^3$ – micrograms per cubic metre of air ppm – parts per million $ng/m^3$ – nanograms per cubic meter of air

AAAQO – one-hour Alberta Ambient Air Quality Objective n/a – no one-hour objective bd – below detection limit

(2) The one-hour maximum ozone concentration of 0.043 ppm was measured at the Husky Refinery on May 20, 2004; this concentration is below the one-hour AAAQO for ozone.

(3) The maximum one-hour hydrogen sulphide concentration of 0.020 ppm was measured on July 30, 2002 at the Husky Refinery. This concentration is above the one-hour AAAQO. In total, there were eight exceedances of the one-hour Objective for hydrogen sulphide. Six of the exceedances were measured at the Husky Refinery. Two of the exceedances were measured at Greif Containers, however, hydrogen sulphide at this site is suspected to have originated from the upwind Husky Refinery. Although hydrogen sulphide exceeded the one-hour AAAQO, the concentrations measured were well below levels that are known to cause human health effects. Hydrogen sulphide concentrations at the other three monitoring sites were very low or below the detection limit of monitoring equipment.

The one-hour AAAQO for hydrogen sulphide is based on odour perception. Therefore, the repeated exceedance of hydrogen sulphide measured by the MAML suggests that there is potential for odour nuisance events in Lloydminster.

(4) Total reduced sulphur concentrations measured at the Husky Refinery site were relatively high compared to hydrogen sulphide. For example, on August 6, 2004, the hydrogen sulphide concentration (a component of total reduced sulphur) was 0.011 ppm while the total reduced sulphur concentration was 0.016 ppm; from an odour perspective this suggests that on occasion, a significant component of the total reduced sulphur concentration is unidentified, perhaps highly odourous sulphur compounds. Similarly on May 14, 2002, at the Husky Blackfoot Battery #2, the hydrogen sulphide concentration was 0.001 ppm while the total reduced sulphur concentration was 0.010 ppm.

(5) The maximum one-hour polycyclic aromatic hydrocarbon concentration of 27 $ng/m^3$ was measured on November 25, 2004 at the Greif Containers Site. The probable source of this elevated value was exhaust emissions from vehicle traffic (idling cars, diesel trucks, oilfield service vehicles).

(6) Resuspended road dust and vehicle emissions may have contributed to higher particulate matter concentrations at the Greif Containers Site, Husky Refinery and Husky Blackfoot Battery #2. The highest concentrations of total suspended particulates (TSP), particulate matter with a diameter less than ten micrometers ($PM_{10}$) and particulate matter with a diameter less than 2.5 micrometers ($PM_{2.5}$) were 1418 $\mu g/m^3$ were 946 $\mu g/m^3$ and 151 $\mu g/m^3$, respectively. These concentrations were all measured at the Husky Blackfoot Battery #2. Vehicle movement at the Battery as well as oilfield vehicle traffic on unpaved roads surrounding the Battery site may have contributed to dust at this monitoring location. Also, low wind speeds may have hindered dispersion of the lingering particulate matter.

(7) Carbon monoxide concentrations were low. The maximum one-hour concentration of 0.8 ppm was measured on February 26, 2003 at the ADM Agri-Industries site. This concentration is significantly below the 1-hour AAAQO of 13 ppm for carbon monoxide.

(8) Methane concentrations ranged from 1.6 ppm to 4.9 ppm, while total hydrocarbon concentrations ranged from 1.8 ppm to 5.2 ppm. The maximum one-hour methane concentration was measured on February 26, 2003 at ADM Agri-Industries, the maximum total hydrocarbon concentration was measured on February 18, 2004 at the Husky Battery, while the highest reactive hydrocarbon concentration was measured on July 29, 2002 at the Greif containers site; these concentrations where 4.9 ppm, 5.2 ppm and 2.9 ppm respectively. Elevated reactive hydrocarbon concentrations at Greif Containers may be attributed to emissions from onsite drum painting or enamelling operations.

(9) Several canister samples were also collected to determine the possible species (or types) of volatile organic compounds near Greif Containers as well as the Husky Refinery. Four compounds (toluene, ethylbenzene, xylene, methyl ethyl keytone) were notably elevated and perhaps above the odour threshold of sensitive individuals, however, they were below their respective AAAQOs where applicable. The release of these types of compounds is consistent with other drum manufacturing and refinishing operations that report to the National Pollutant Release Inventory (NPRI). The Lloydminster Greif Containers operation does not currently report the NPRI.

(10) Ammonia and oxides of nitrogen one-hour concentrations measured during the Lloydminster survey were very low.

Alberta's Ambient Air Quality Objectives[1] are established under Section 14 of the Environmental Protection and Enhancement Act (EPEA R.S.A. 2000, c.E-12, as amended). EPEA provides for the development of environmental objectives for Alberta.

The Ambient Air Quality Objectives are used for:

- **Reporting on the state of the atmospheric environment in Alberta.**
- **Reporting to Albertans on the quality of the air through Alberta's Air Quality Index (AQI).**
- **Establishing approval conditions for regulated industrial facilities.**
- **Evaluating proposals to construct facilities that will have air emissions.**
- **Guiding special ambient air quality surveys.**
- **Assessing compliance near major industrial air emission sources.**

Some of Alberta's Ambient Air Quality Objectives are based on odour perception. This is the case for ammonia, nitrogen dioxide and hydrogen sulphide. For these chemicals, people are likely to detect an odour at concentrations well below levels that may affect human health.

Alberta's Ambient Air Quality Objectives for one-hour concentrations of pollutants monitored by the MAML and the basis for the objective are listed in Table 2.

**Table 2: Alberta's Ambient Air Quality Objectives for pollutants measured by the MAML.**

| Pollutant | One-hour AAAQO (ppm*) | Basis for Objective |
|---|---|---|
| Ammonia | 2 | odour perception |
| Carbon monoxide | 13 | oxygen carrying capacity of blood |
| Nitrogen dioxide | 0.212 | odour perception |
| Ozone | 0.082 | reduction of lung function and effects on vegetation |
| Hydrogen sulphide | 0.01 | odour perception |
| Sulphur dioxide | 0.172 | pulmonary function |

* Parts per million by volume.

[1] *Alberta Ambient Air Quality Objectives.* Alberta Environment. April 2005.

The Mobile Air Monitoring Laboratory (MAML) is a 27-foot (8.2 m) vehicle that has been specially designed and equipped to measure air quality. It houses a variety of instruments that continuously sample the air at specified time or distance intervals. The MAML is equipped with:

- **a dual computer system custom-programmed to accept and record the measurement of air samples from each analyser,**
- **a GPS (Global Positioning System) that identifies the MAML's location as it moves around Alberta,**
- **an exhaust purifying system that minimizes emissions from the vehicle and**
- **two on-board generators that are also equipped with exhaust scrubbers**

The pollutants measured by the MAML are listed in Table 3.

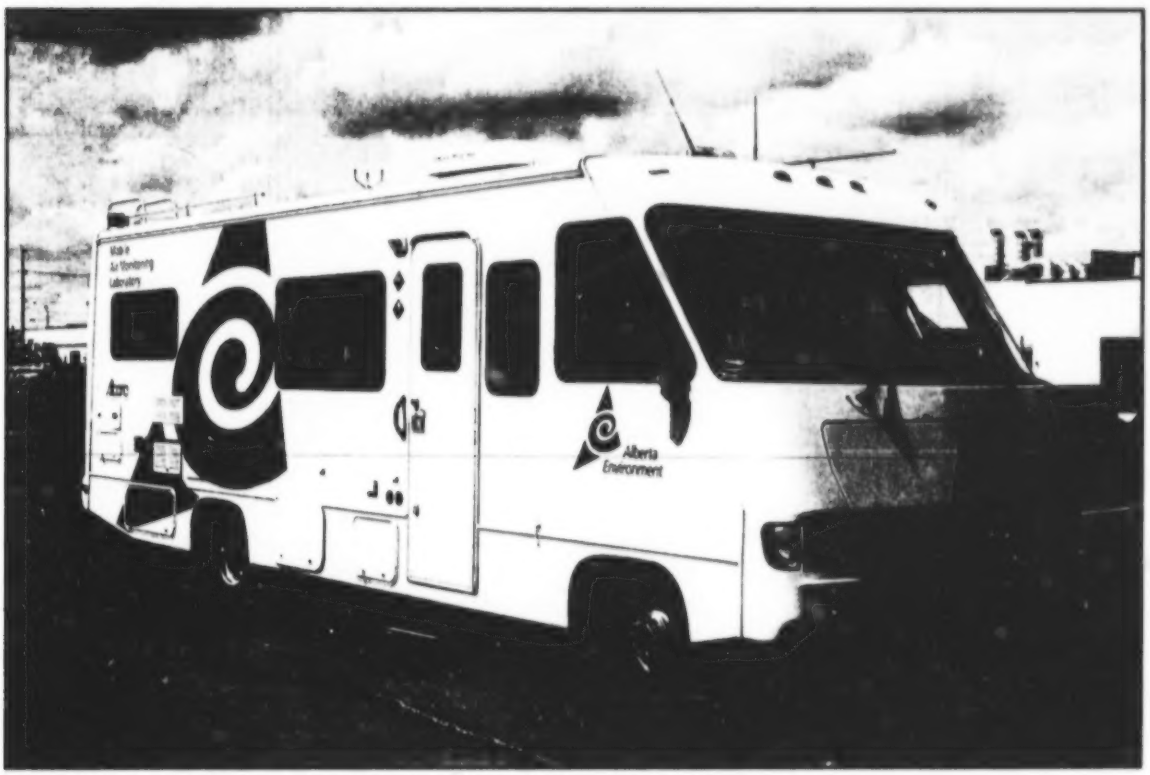


**Figure 1:** **Alberta Environment's Mobile Air Monitoring Laboratory**

**Table 3** **Pollutants monitored by the MAML (including minimum detection limits and operating ranges).**

| Pollutant | Operating Range | |
|---|---|---|
| | Lower Detection Limit* | Upper Detection Limit** |
| Ammonia **($NH_3$)** | 0.001 ppm | 5 ppm |
| Carbon Monoxide **(CO)** | 0.1 ppm | 50 ppm |
| *Hydrocarbons* – Methane **($CH_4$)** | 0.1 ppm | 10 ppm |
| *Hydrocarbons* – Reactive Hydrocarbons **(RHC)** | 0.1 ppm | 20 ppm |
| *Hydrocarbons* – Total Hydrocarbons **(THC)** | 0.1 ppm | 20 ppm |
| *Hydrocarbons* – Polycyclic Aromatic Hydrocarbons **(PAH)** | 3 $ng/m^3$ | 1000 $ng/m^3$ |
| Nitrogen dioxide **($NO_2$)** | 0.001 ppm | 1 ppm |
| Nitric Oxide **(NO)** | 0.001 ppm | 1 ppm |
| Oxides of nitrogen **($NO_x$)** | 0.001 ppm | 1 ppm |
| Ozone **($O_3$)** | 0.001 ppm | 0.5 ppm |
| *Particulates* – Total Suspended Particulates **(TSP)** | 1 $\mu g/m^3$ | 1.0 $g/m^3$ |
| *Particulates* – Particulate Matter <10μm **($PM_{10}$)** | 1 $\mu g/m^3$ | 1.0 $g/m^3$ |
| *Particulates* – Particulate Matter <2.5μm **($PM_{2.5}$)** | 1 $\mu g/m^3$ | 1.0 $g/m^3$ |
| *Sulphur Compounds* - Hydrogen Sulphide **($H_2S$)** | 0.001 ppm | 1 ppm |
| *Sulphur Compounds* - Total Reduced Sulphur **(TRS)** | 0.001 ppm | 1 ppm |
| Sulphur Dioxide **($SO_2$)** | 0.001 ppm | 1 ppm |

ppm - parts per million

$ng/m^3$ = nanograms per cubic metre

$\mu g/m^3$ = micrograms per cubic metre

$g/m^3$ = grams per cubic metre

* The ***lower detection limit*** indicates the *minimum* amount of pollutant and the lower limit of meteorological data can be measured by the instrument.

** The ***upper detection limit*** indicates the *maximum* amount of pollutant the instrument can detect and the upper limit for meteorological data measured. This limit is set to provide the optimum precision over that range. The upper limit can be raised, however, precision at the lower levels (where most levels are monitored) is then compromised.

Alberta Environment used the MAML to monitor air quality in the Lloydminster area. Air quality was monitored on the following dates:

- **Spring (May 14, 15 and 16, 2002)**
- **Summer (July 29, 30 and 31, 2002)**
- **Fall (October 7, 8 and 9, 2002)**

- **Winter (February 26, 27 and 28, 2003)**

- **Winter (February 18, 19 and 20, 2004)**
- **Spring (May 19, 20 and 21, 2004)**
- **Summer (August 4, 5 and 6 2004)**
- **Fall (November 24, 25 and 26, 2004)**

The monitoring sites were selected based on public complaints and consultation with Alberta Environment's Compliance and Industrial Approvals staff in the Central Region Office. The location of the facilities are described in Table 4, mapped on Figure 2 and depicted in Figures 3 and 4.

Monitoring was conducted for a minimum of one hour at each location to allow comparison to Alberta's Ambient Air Quality Objectives. A total of 124 hours of air quality data were collected.

**Table 4: Locations monitored by the MAML (2002, 2003 and 2004 Lloydminster Area surveys).**

| Site # | Facility | 2002 | | | 2003 | 2004 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Spring | Summer | Fall | Winter | Winter | Spring | Summer | Fall |
| | | May | Jul | Oct | Feb | Feb | May | Aug | Nov |
| 1 | **Greif Containers** 5408-52 Avenue | 14, 15, 16 | 29, 30, 31 | 8, 9 | 26, 27 | 18, 19, 20 | 19, 20, 21 | 4, 5, 6 | 24, 25, 26 |
| 2 | **ADM Agri-Industries Ltd** 4805-62 Avenue | 14, 15, 16 | *none* | 7, 8, 9 | 26, 27, 28 | 19, 20 | 20 | 4, 5, 6 | 24, 25, 26 |
| 3 | **Husky North Blackfoot Battery #2** LSD 13-30-50-1 W4 | 14, 15, 16 | 29 | 7, 8 | *none* | 18 | 20 | 4 | 24 |
| 4 | **Little Dipper Used Oil Recovery** LSD SW-4-50-1 W4 | 14, 15, 16 | 30 | 7 | *none* | 19 | 19 | 5 | 25 |
| 5 | **Husky Refinery** LSD NW-1-50-1 W4 | 14, 15, 16 | 29, 30, 31 | 7, 8, 9 | 26, 27, 28 | 18, 19, 20 | 19, 20, 21 | 4, 5, 6 | 24, 25 |

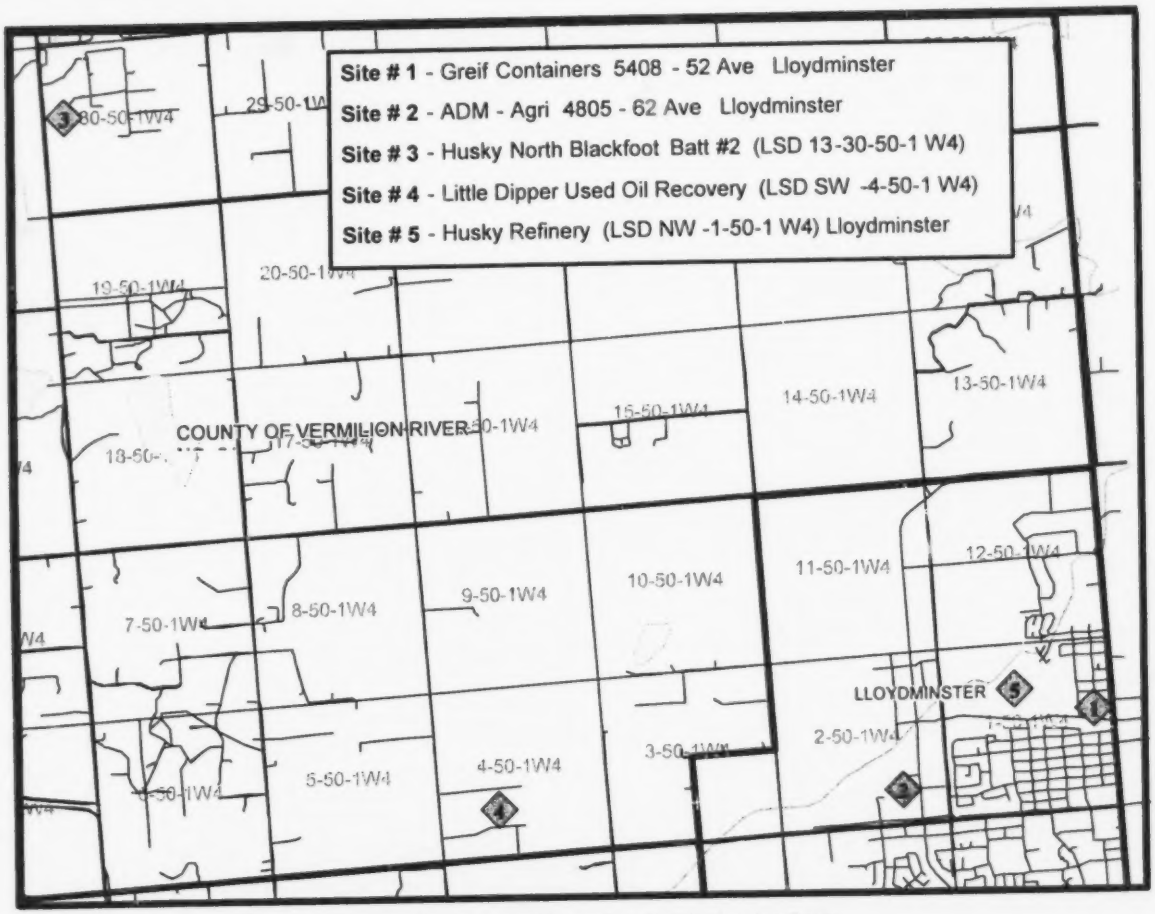
Site # 1 - Greif Containers 5408 - 52 Ave Lloydminster
Site # 2 - ADM - Agri 4805 - 62 Ave Lloydminster
Site # 3 - Husky North Blackfoot Batt #2 (LSD 13-30-50-1 W4)
Site # 4 - Little Dipper Used Oil Recovery (LSD SW -4-50-1 W4)
Site # 5 - Husky Refinery (LSD NW -1-50-1 W4) Lloydminster
COUNTY OF VERMILION RIVER
LLOYDMINSTER
20-50-1W4
19-50-1W4
14-50-1W4
13-50-1W4
11-50-1W4
10-50-1W4
9-50-1W4
8-50-1W4
7-50-1W4
5-50-1W4
4-50-1W4
2-50-1W4

**Figure 2:** **Locations monitored by the MAML in the Lloydminster Area.**

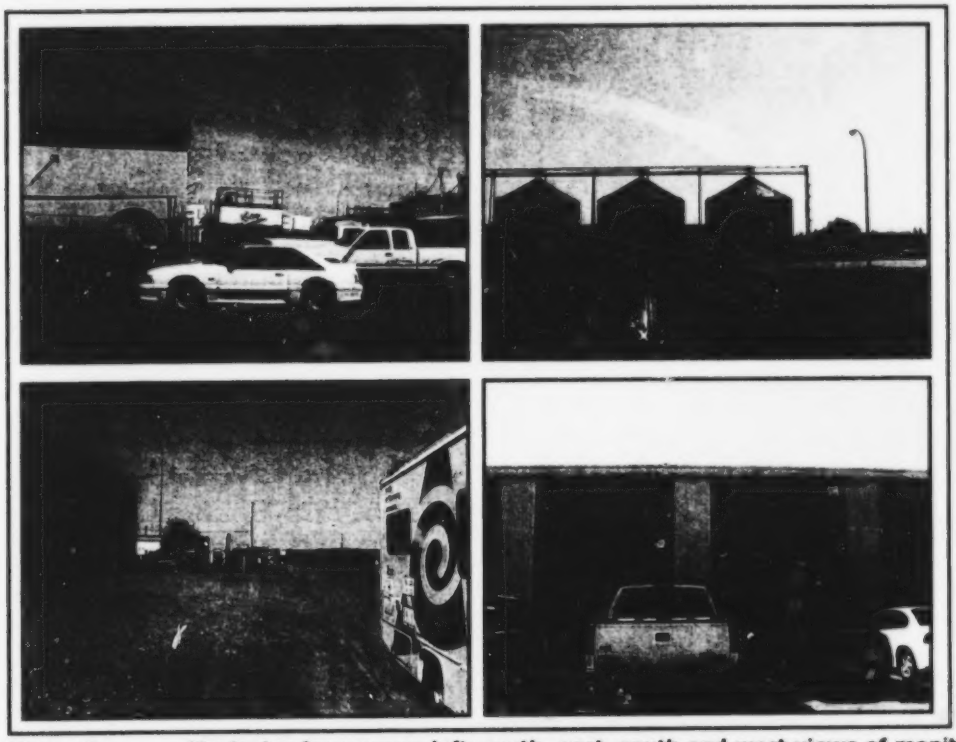

**Figure 3:** **Clockwise from upper left: north, east, south and west views of monitoring location #2 adjacent to the AMD Agri-Industries Plant.**

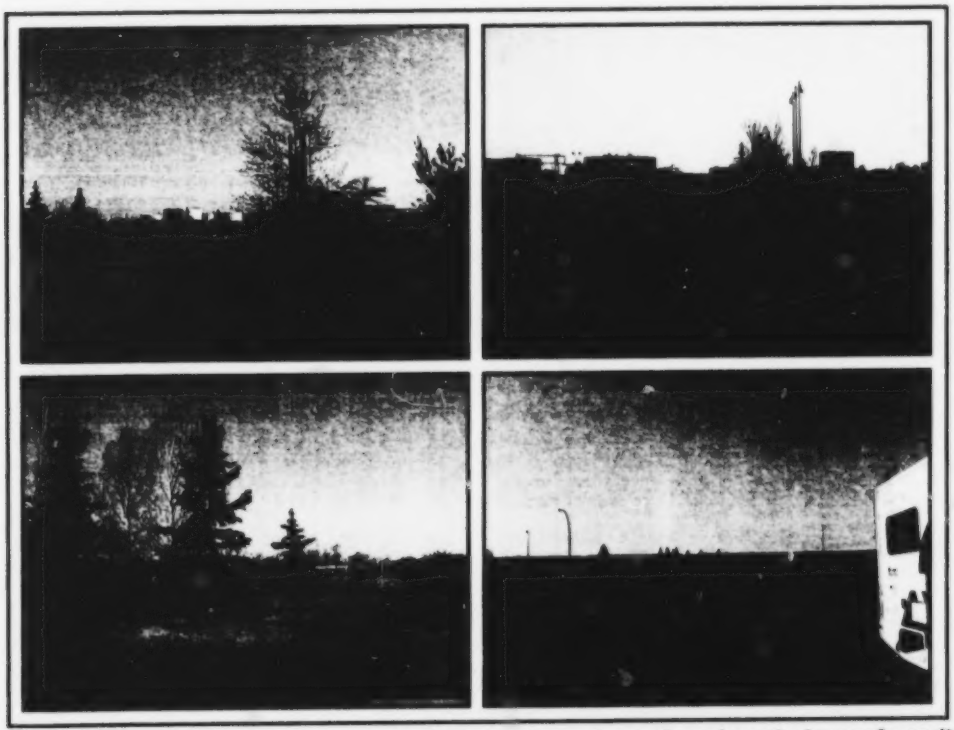

**Figure 4:** **Clockwise from upper left: north, east, south and west views of monitoring location #5 adjacent to the Husky Oil Refinery and rail tank cars.**

The median concentration is a common way of representing the central value for environmental data. Most environmental data usually consist of a distribution that is skewed to the right; that is most data values are low and only a few are high. The arithmetic mean will be biased by the high concentrations and will reveal a value that may not be representative of the central value for the data set. The median is the middlemost value in the data set, dividing the distribution into two equal halves. Therefore, the median is more representative of the central value of the data distribution. Fifty percent of the values in the dataset are below the median and fifty percent are above.

For example, consider a data distribution consisting of five numbers: 1, 2, 2, 3 and 10. The arithmetic mean of these data is 3.6 and the median is 2. In this case, the arithmetic mean is biased high by the extreme value of 10. The median value is actually a true central value of the data distribution.

Many areas in Alberta are pristine and certain pollutants that Alberta Environment monitors for are found in concentrations below the lower detection limit of the instruments onboard the MAML. Consider a dataset that contains 4 concentrations below the detection limit and one concentration within the operating range of the MAML instruments; with this data set, it is possible to have an overall median concentration that is 'undetectable' or below the lower detection limit while still having a 'detectable' maximum value.

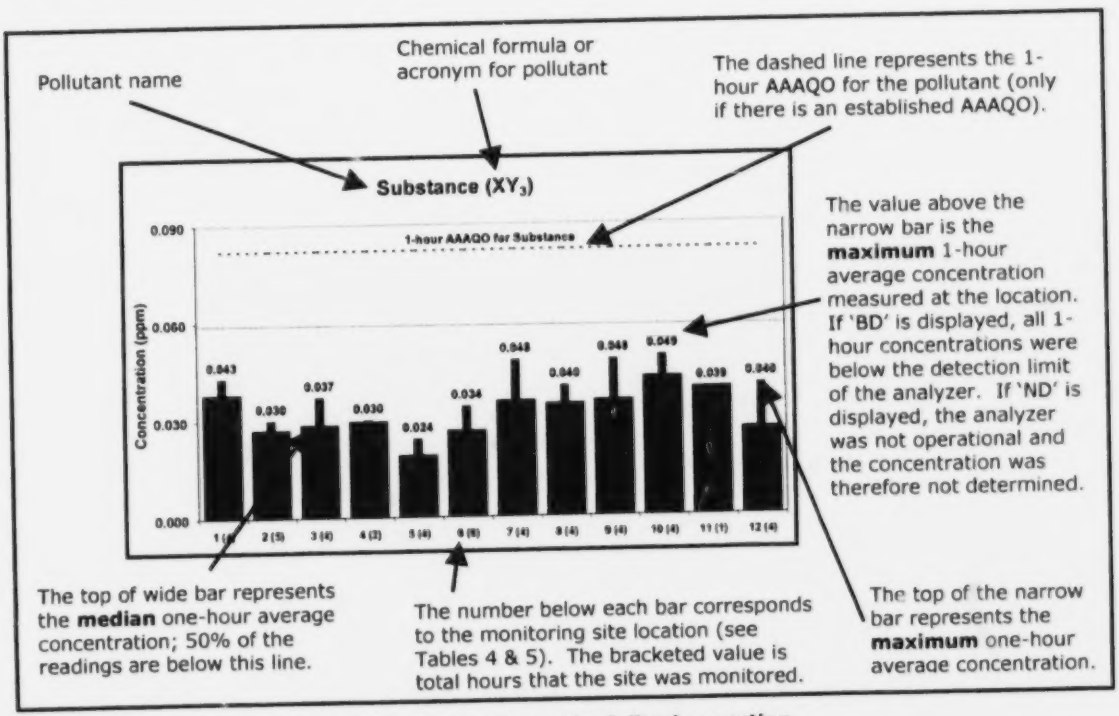
Pollutant name
Chemical formula or acronym for pollutant
The dashed line represents the 1-hour AAAQO for the pollutant (only if there is an established AAAQO).
Substance ($XY_3$)
1-hour AAAQO for Substance
Concentration (ppm)
0.090
0.060
0.030
0.000
0.043
0.030
0.037
0.030
0.024
0.034
0.048
0.040
0.048
0.049
0.039
0.040
1 (5)
2 (5)
3 (4)
4 (3)
5 (4)
6 (5)
7 (4)
8 (4)
9 (4)
10 (4)
11 (1)
12 (4)
The value above the narrow bar is the **maximum** 1-hour average concentration measured at the location. If 'BD' is displayed, all 1-hour concentrations were below the detection limit of the analyzer. If 'ND' is displayed, the analyzer was not operational and the concentration was therefore not determined.
The top of wide bar represents the **median** one-hour average concentration; 50% of the readings are below this line.
The number below each bar corresponds to the monitoring site location (see Tables 4 & 5). The bracketed value is total hours that the site was monitored.
The top of the narrow bar represents the **maximum** one-hour average concentration.

**Figure 5:** **Key for interpreting the graphs in the following section.**

# Ammonia ($NH_3$)

**Ammonia is a colourless gas with a well-known pungent odour; it is commonly found in household cleaners. $NH_3$ is produced both by natural and man-made sources. Some natural sources of $NH_3$ include the decay of plant material and animal waste. A small portion is also released during respiration. In Alberta, the fertilizer industry is the main industrial source of $NH_3$. The industry produces synthetic $NH_3$ for either direct application to soil as a fertilizer or as a raw material for use in the production of other high nitrogen fertilizer products. The other major source of $NH_3$ is commercial feedlots, specifically from their large amounts of decaying animal wastes.**

Ammonia concentrations were very low at all monitoring locations in the Lloydminster Area. Elevated ammonia concentrations are commonly found near feedlots, confined feeding operations and fertilizer manufacturing plants.

The highest one-hour $NH_3$ concentration detected during the survey (0.016 ppm) was measured at ADM Agri-Industries on May 16, 2002. The maximum $NH_3$ concentration measured at this site is less than one per cent of the one-hour Alberta Ambient Air Quality Objective.

The overall median $NH_3$ concentration for this survey was 0.001 ppm.

$NH_3$ concentrations measured in this survey are significantly lower than concentrations found in other MAML surveys. Maximum one-hour $NH_3$ concentrations from other MAML surveys ranged from 0.005 ppm (2001/2002 Cold Lake/Bonnyville survey) to 0.557 ppm (2001/2002 Fort Saskatchewan/Redwater survey).

Ammonia is not typically measured at Alberta's permanent air monitoring stations.

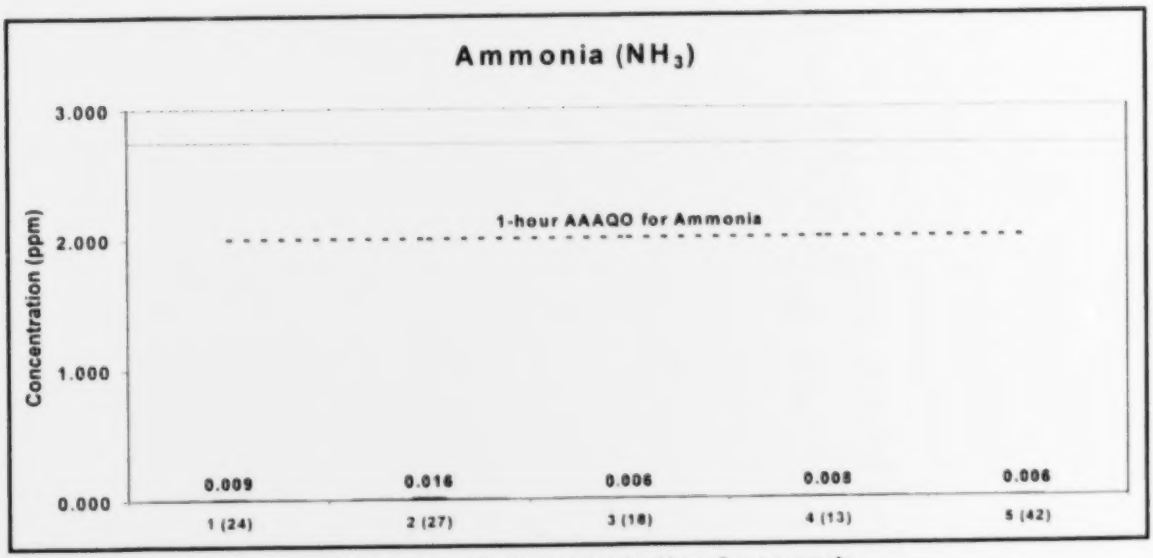


**Figure 6:** **One-hour median and maximum concentrations for ammonia.**

# Carbon Monoxide (CO)

**Carbon monoxide (CO) is a colourless, odourless gas emitted into the atmosphere primarily by motor vehicles. Minor sources include fireplaces, industry, aircraft and natural gas combustion. The major source of carbon monoxide in urban locations is vehicle exhaust emissions.**

Carbon monoxide concentrations were very low at all monitoring locations. CO concentrations are generally measured in low concentrations in small urban centres, such as Lloydminster, due to the lack of traffic congestion.

The maximum one-hour CO concentration of 0.8 ppm was measured at the ADM Agri-Industries site on February 26, 2003. The maximum one-hour concentration measured at this site is six per cent of the one-hour objective for CO. Probable sources at this location are the vehicle emissions and the ADM main stack.

The overall median concentration in the Lloydminster survey was 0.2 ppm.

CO concentrations measured during this survey were lower than concentrations found in other mobile surveys. Maximum one-hour CO concentrations from other MAML surveys ranged from 0.5 ppm (2000/2001 Wabaman survey) to 2.7 ppm (2000/2001 Edmonton – Whitemud Drive survey).

In 2004, the maximum one-hour CO concentration measured by a permanent monitoring station was 6.6 ppm (Edmonton Northwest).

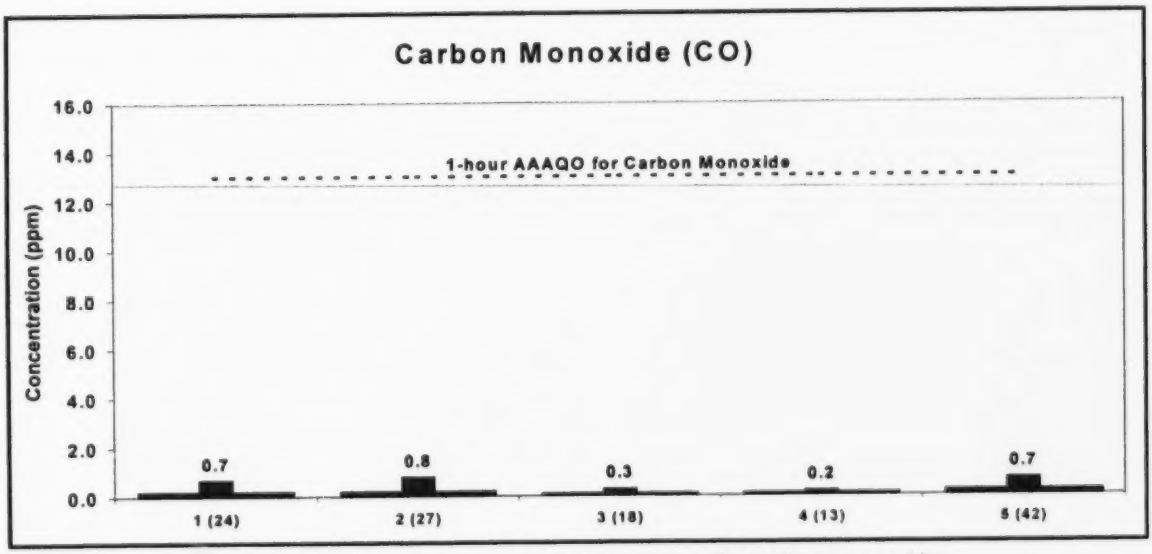


**Figure 7:** **One-hour median and maximum concentrations for carbon monoxide.**

## Hydrocarbons

**The term "total hydrocarbons" (THC) refers to a broad family of chemicals that contain carbon and hydrogen atoms. Methane ($CH_4$) is the most common natural hydrocarbon in the earth's atmosphere. Reactive hydrocarbons (RHC) are important because they can contribute to summertime smog or may be toxic at high concentrations. Some sources of hydrocarbons include vegetation, vehicle emissions, oil and gas processing, chemical processing, dry cleaning, fireplaces, natural gas combustion, aircraft traffic and evaporation of solvents.**

**Polycyclic aromatic hydrocarbons (PAHs) are a class of chemicals that are usually contained in soot and smoke. There are more than 100 different PAHs with varying levels of toxicity. They are formed during the incomplete combustion of gasoline, diesel, oil, coal, wood, garbage or other organic substances. Tobacco smoke and charbroiled meats are common sources of PAHs. Other outdoor PAH sources include vehicle emissions, wood smoke from fireplaces, smoke from forest fires and industrial facilities. PAHs occur in the atmosphere in the vapour phase or attached to dust particles. The monitoring instrument on the MAML will analyze only particulate bound PAHs.**

The maximum one-hour methane concentration of 4.9 ppm was measured at the ADM Agri-Industries site on February 26, 2003. The maximum one-hour PAH concentration of 27 $ng/m^3$ was measured at the Greif Containers site on November 25, 2004. The high PAHs values were likely due to vehicle exhaust and idling trucks at the upwind Husky Refinery.

The maximum one-hour RHC concentration of 2.9 ppm was measured on July 29, 2002 at the Greif Containers site. Strong paint-like odours were noted at this site; this elevated concentration may be attributed to emissions from oil drum painting operations at Greif.

The maximum one-hour THC concentration of 5.2 ppm was measured on February 18, 2004 at the Husky Blackfoot Battery #2. A combination of elevated methane and reactive hydrocarbon concentrations were measured at this location and may have been the result of fugitive emissions from pipes, flanges and other heavy oil processing equipment at the Battery Site.

The Lloydminster surveys found overall median concentrations of 2.2 ppm, 0.2 ppm and 2.5 ppm for $CH_4$, RHC, and THC respectively.

The hydrocarbon concentrations measured during the Lloydminster study are within the ranges of concentrations measured in other MAML surveys.

Maximum one-hour $CH_4$ concentrations from other MAML surveys ranged from 2.2 ppm (1999/2000 Bow Corridor survey) to 4.6 ppm (2001/2002 Cold Lake/Bonnyville survey).

Maximum one-hour RHC concentrations from other MAML surveys ranged from 0.5 ppm (2000/2001 Wabaman survey) to 7.1 ppm (2001/2002 Cold Lake/Bonnyville survey).

Maximum one-hour THC concentrations from other MAML surveys ranged from 3.3 ppm (2000/2001 Wabaman survey) to 9.7 ppm (2001/2002 Cold Lake/Bonnyville survey).

Maximum one-hour PAHs concentrations from other MAML surveys ranged from 11 $ng/m^3$ (2000/2001 Wabaman survey) to 113 $ng/m^3$ (2001 Whitecourt survey).

The maximum one-hour THC concentration measured by a permanent monitoring station was 25.9 ppm (Edmonton East) in 2004.

$CH_4$, RHC and PAHs are typically not measured at Alberta's permanent air monitoring stations.

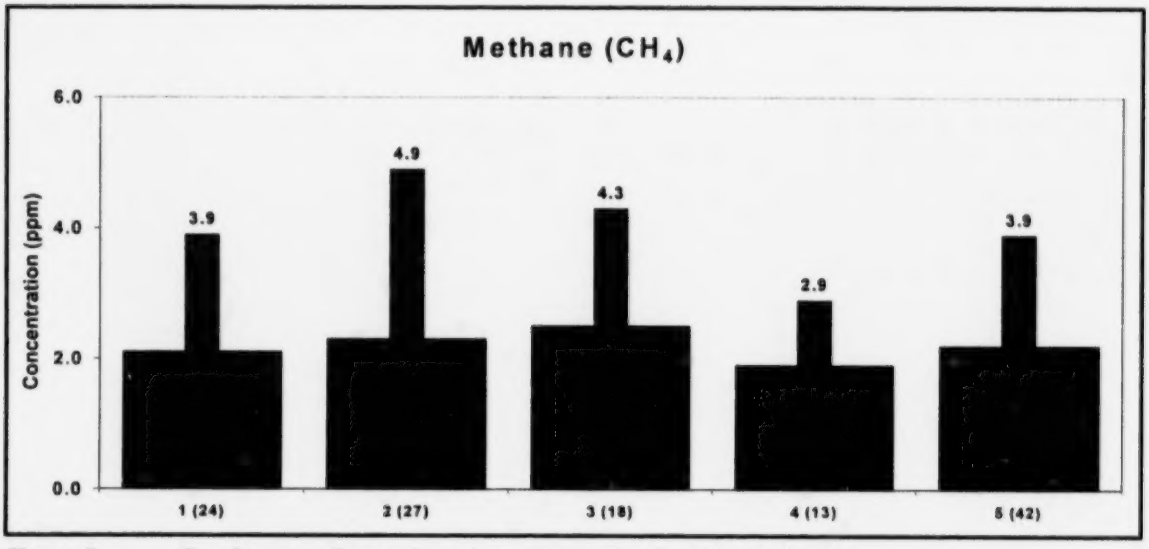


**Figure 8:** **One-hour median and maximum concentrations for methane.**

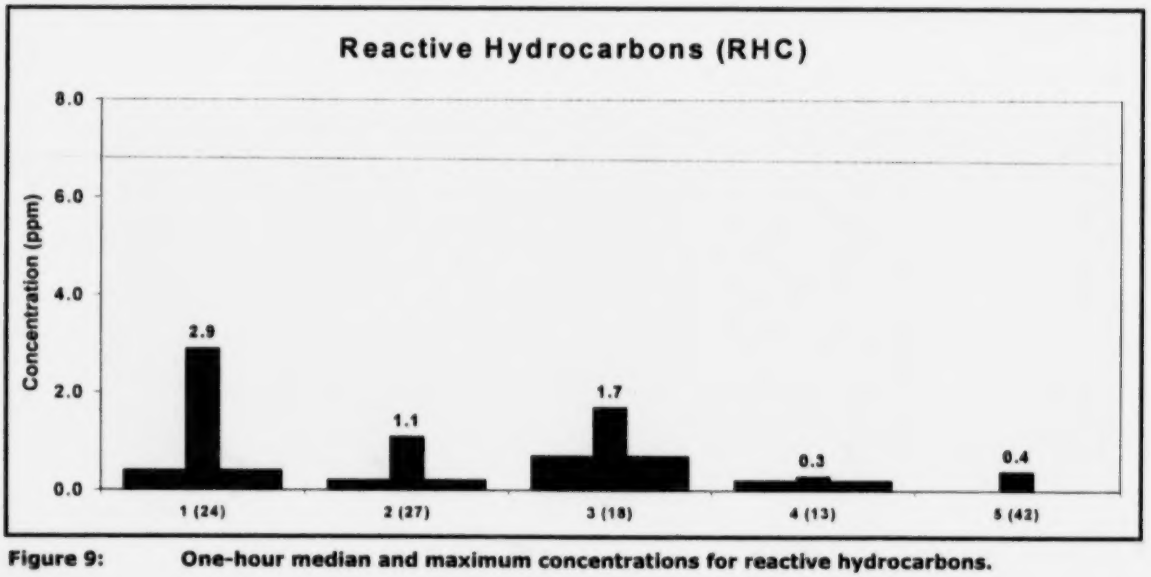


**Figure 9:** **One-hour median and maximum concentrations for reactive hydrocarbons.**

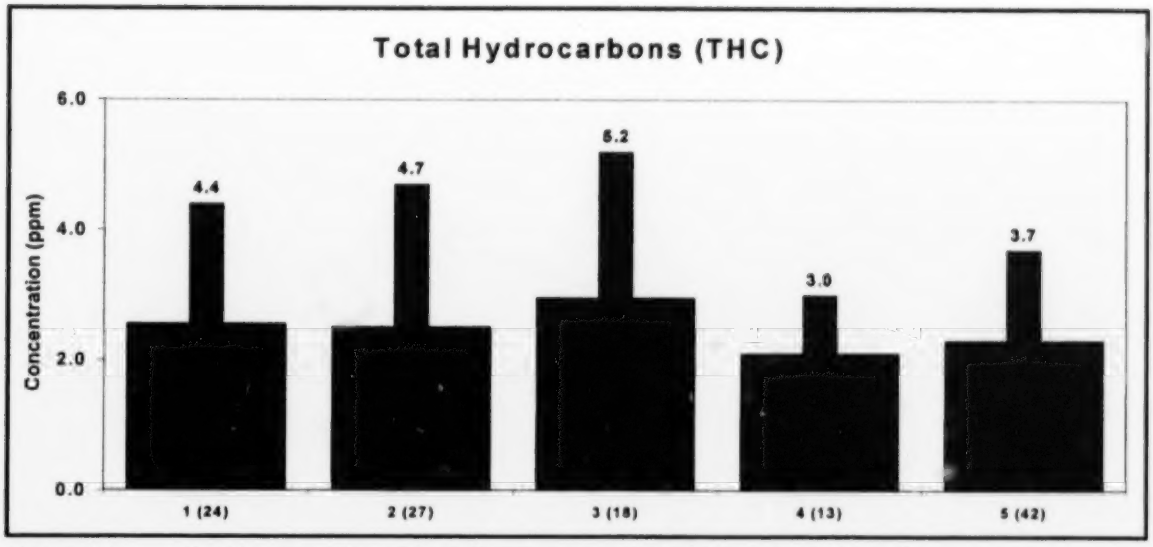


**Figure 10:** **One-hour median and maximum concentrations for total hydrocarbons.**

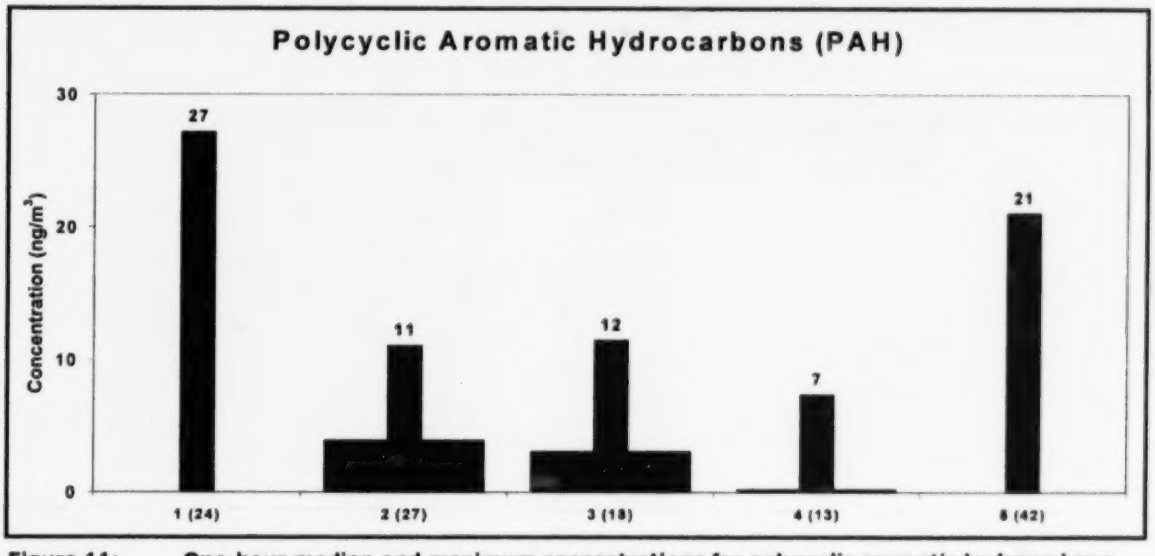


**Figure 11:** **One-hour median and maximum concentrations for polycyclic aromatic hydrocarbons.**

## Oxides of Nitrogen ($NO_2$, NO, $NO_x$)

**Oxides of nitrogen ($NO_x$) are the total of nitrogen dioxide ($NO_2$) and nitric oxide (NO). During high temperature combustion - as in the burning of natural gas, coal, oil and gasoline - atmospheric nitrogen may combine with molecular oxygen to form NO. NO is colourless and odourless. Most NO in the ambient air is oxidized to form $NO_2$. $NO_2$ is a reddish-brown gas with a pungent odour. The major sources of oxides of nitrogen in urban areas are vehicle and power plant emissions. Processes associated with the oil and gas industry also emit oxides of nitrogen into the atmosphere.**

Nitrogen dioxide concentrations were well below Alberta's Ambient Air Quality Objectives in the Lloydminster Area survey.

The maximum one-hour $NO_2$ concentration of 0.038 ppm was recorded at ADM Agri-Industries on February 26, 2003. This $NO_2$ concentration is 18 percent of the one-hour objective.

There are several probable sources of $NO_2$ at this site including vehicle traffic and emissions from the AMD Agri-Industries main stack.

Surrounding Lloydminster, there are several heavy oil processing and extraction units. As such, other potential sources of $NO_x$ in this survey include emissions from upwind oilfield service vehicles, compressors and oil storage tank heaters.

It should be noted that the maximum $NO_2$ concentration measured during this survey was recorded in the winter. Elevated $NO_2$ concentrations may also be the result of local fuel combustion for home heating in Lloydminster.

The overall $NO_2$ median concentration in the 2002-2004 Lloydminster Area survey was 0.006 ppm.

The maximum $NO_2$ concentrations measured during this survey are lower than concentrations measured in other surveys. Maximum one-hour $NO_2$ concentration from other MAML surveys range from 0.014 ppm (2001/2002 Cold Lake/Bonnyville survey) to 0.051 ppm (2001/2002 Fort Saskatchewan/Redwater survey).

The maximum one-hour $NO_2$ concentration measured by a permanent monitoring station was 0.183 ppm (Fort McMurray – Athabasca Valley) in 2004.

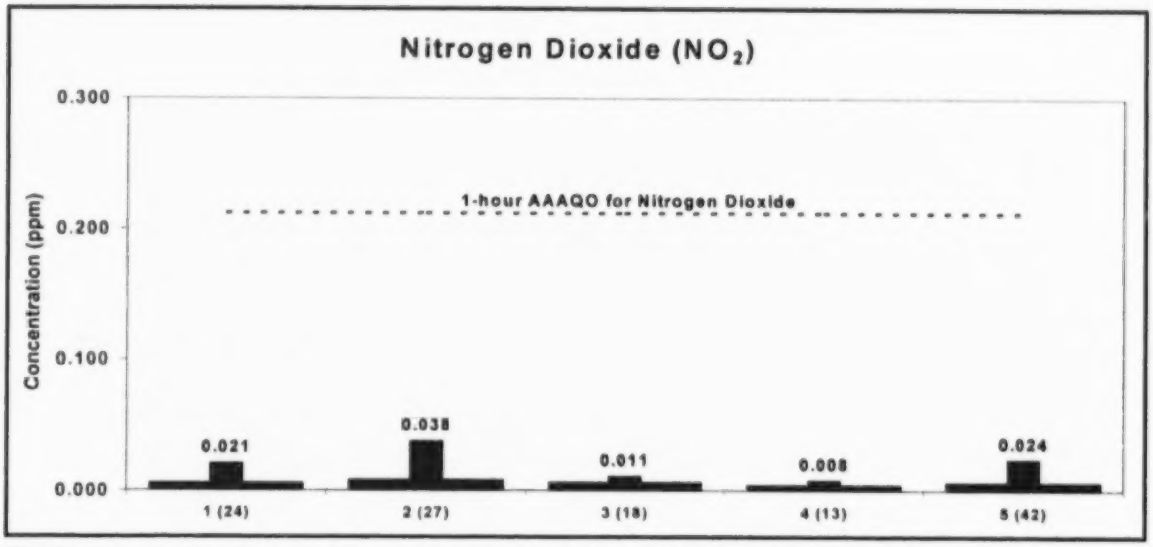


**Figure 12:** **One-hour median and maximum concentrations for nitrogen dioxide**

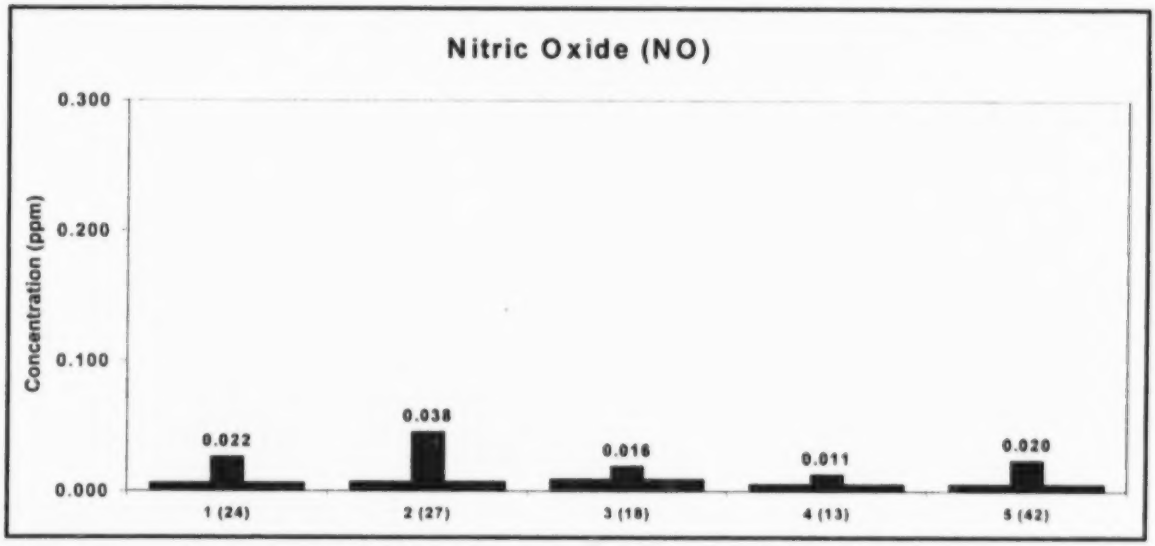


**Figure 13:** **One-hour median and maximum concentrations for nitric oxide.**

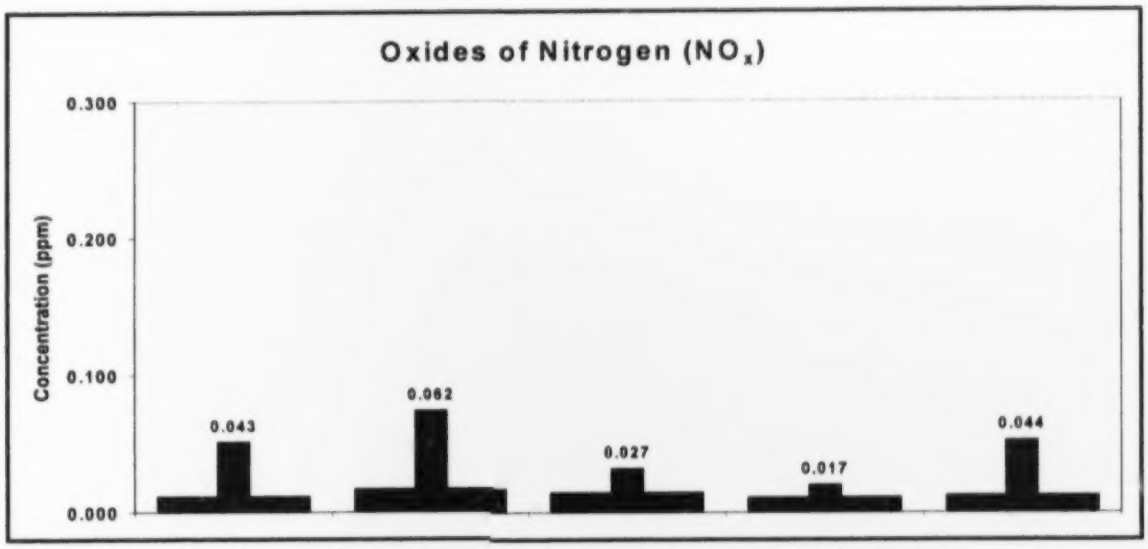


**Figure 14:** **One-hour median and maximum concentrations for oxides of nitrogen.**

# Ozone ($O_3$)

**Ozone in the lower atmosphere is produced by the reaction of oxides of nitrogen and volatile organic compounds in the presence of sunlight, and transport of $O_3$ from the upper atmosphere to ground level. Transport from the upper atmosphere is likely the dominant ozone producing process in the fall, winter and early spring seasons. $O_3$ concentrations are generally lower in urban centres due to the destruction of $O_3$ by nitric oxide.**

Ozone concentrations in the Lloydminster Area survey did not exceed the Alberta Ambient Air Quality Objective.

The maximum one-hour $O_3$ concentration of 0.043 ppm was recorded at the Husky Refinery on May 20, 2004. This maximum $O_3$ value is approximately 53 percent of the one-hour objective.

Higher $O_3$ levels are usually observed in the afternoon because of more sunlight, warmer temperatures and more vertical mixing of the atmosphere. In the Lloydminster survey, elevated concentrations of ozone were measured in the early to mid-afternoon.

The median $O_3$ concentration for the Lloydminster Area survey was 0.030 ppm.

The $O_3$ concentrations measured in this survey are similar to those found in previous surveys. Maximum $O_3$ concentrations from other MAML surveys ranged from 0.034 ppm (2003 Banff survey) to 0.059 ppm (2000/2001 Edmonton-Whitemud survey).

The maximum $O_3$ concentration measured at Alberta's permanent monitoring stations was 0.092 ppm (Edmonton East) in 2004.

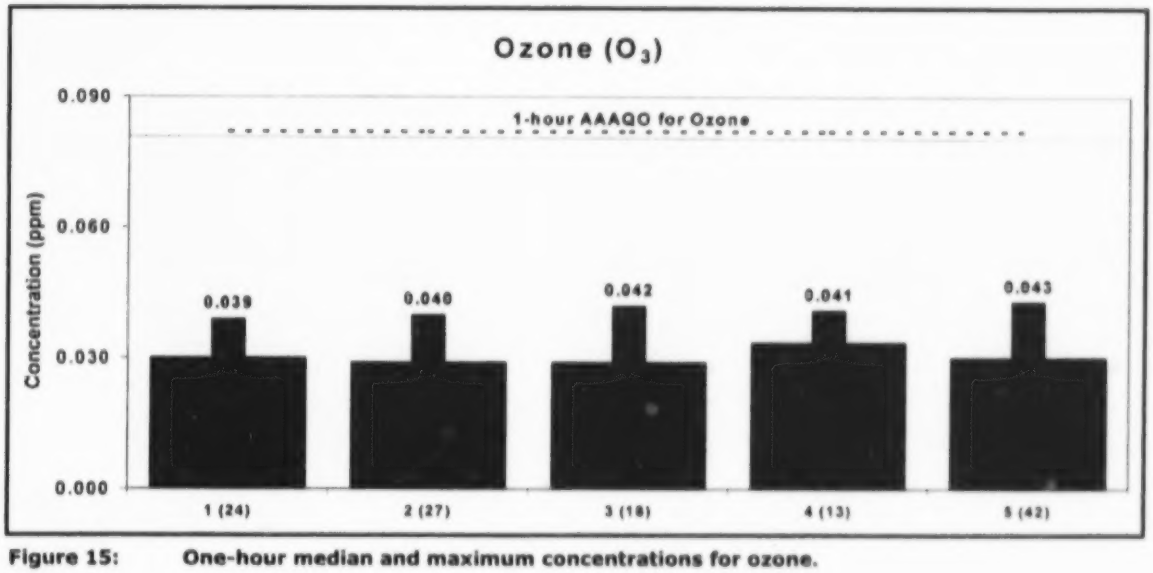


**Figure 15: One-hour median and maximum concentrations for ozone.**

## Particulate Matter (TSP, $PM_{10}$, $PM_{2.5}$)

**Total suspended particulates (TSP) refer to all particles up to 500 μm (micrometers) in diameter (a human hair is about 70μm in diameter) and are important primarily from a nuisance perspective. Particles less than 10 μm in diameter ($PM_{10}$) can be inhaled into the nose and throat while smaller particles, less than 2.5 μm in diameter ($PM_{2.5}$), can penetrate into the lungs. Sources of coarse particulate matter (PM10) include soil dust, resuspended road dust, agricultural dust (e.g., harvest), smoke from forest fires and wood burning. Fine particulate matter ($PM_{2.5}$) can originate in the atmosphere because of condensation processes and from combustion processes from sources such as vehicles emissions, industrial emissions, wood burning and forest fires.**

Within the town of Lloydminster, particulate matter concentrations were low. The highest concentrations of particulate matter were measured at the rurally located Husky Blackfoot Batter #2. Oil field service vehicle traffic on both the battery pad and surrounding unpaved gravel roadways may have contributed to the elevated dust concentrations. Dispersion of the resuspended road dust may have been hindered by low wind speeds.

Maximum one-hour TSP, $PM_{10}$ and $PM_{2.5}$ concentrations measured during the survey were 1418 $\mu g/m^3$, 946 $\mu g/m^3$, and 151 $\mu g/m^3$, respectively. All of these concentrations were measured at the Husky Blackfoot Batter on May 14 and 16, 2002.

The overall median concentrations in the Lloydminster Area survey for TSP, $PM_{10}$ and $PM_{2.5}$ were 19 $\mu g/m^3$, 13 $\mu g/m^3$ and 2 $\mu g/m^3$, respectively.

Concentrations of TSP and $PM_{10}$ measured during this survey are lower than concentrations found in other mobile surveys, while $PM_{2.5}$ concentrations were similar to those measured in other mobile surveys.

Maximum one-hour TSP concentrations from other MAML surveys ranged from 37 $\mu g/m^3$ (2003 Banff survey) to 2281 $\mu g/m^3$ (2001/2002 Cold Lake/Bonnyville survey).

Maximum one-hour $PM_{10}$ concentrations from other MAML surveys ranged from 23 $\mu g/m^3$ (2003 Banff survey) to 1188 $\mu g/m^3$ (2001/2002 Cold Lake/Bonnyville survey).

Maximum one-hour $PM_{2.5}$ concentrations from other MAML surveys ranged from 21 $\mu g/m^3$ (2003 Banff survey) to 72 $\mu g/m^3$ (2001/2002 Cold Lake/Bonnyville survey).

The maximum one-hour $PM_{10}$ and $PM_{2.5}$ levels measured in 2003 at the permanent stations in Alberta were 223 $\mu g/m^3$ (Edmonton Northwest) and 189 $\mu g/m^3$ (Fort McMurray – Athabasca Valley), respectively. TSP is not typically monitored at Alberta's permanent monitoring stations.

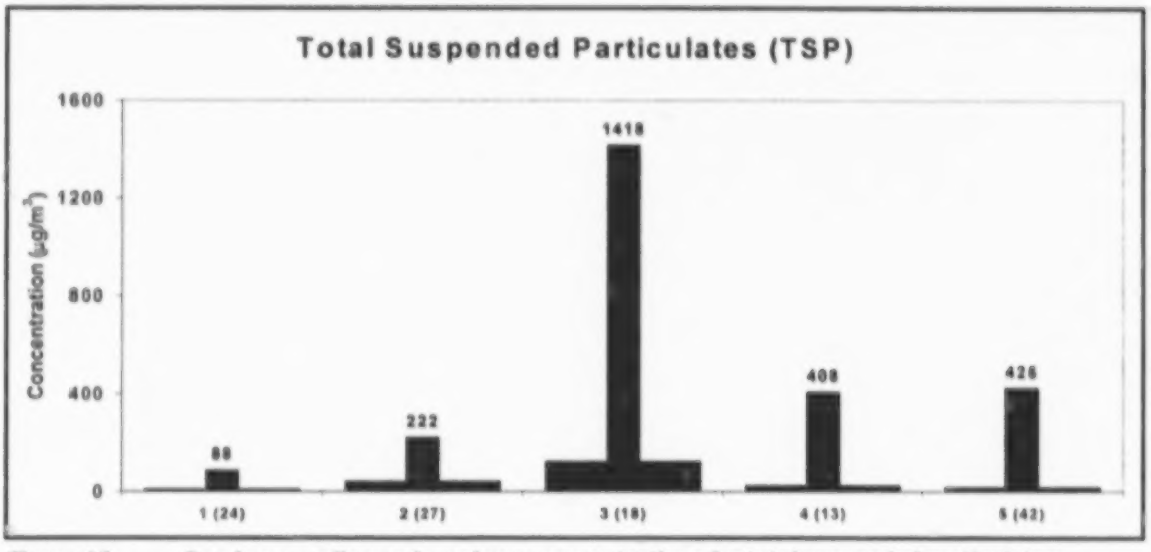


**Figure 16:** One-hour median and maximum concentrations for total suspended particulates.

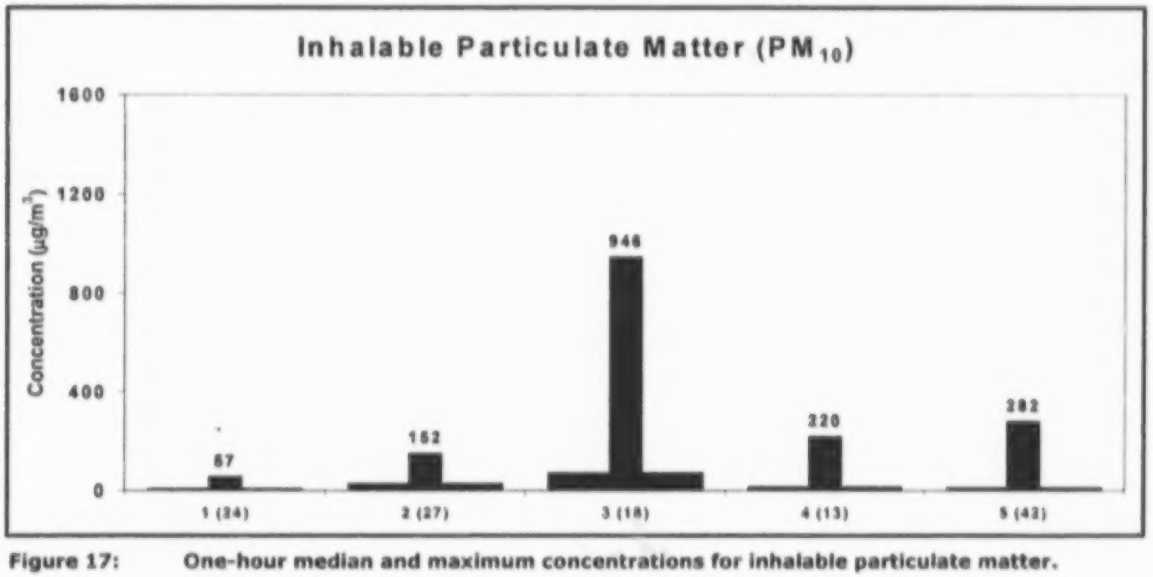


**Figure 17:** One-hour median and maximum concentrations for inhalable particulate matter.

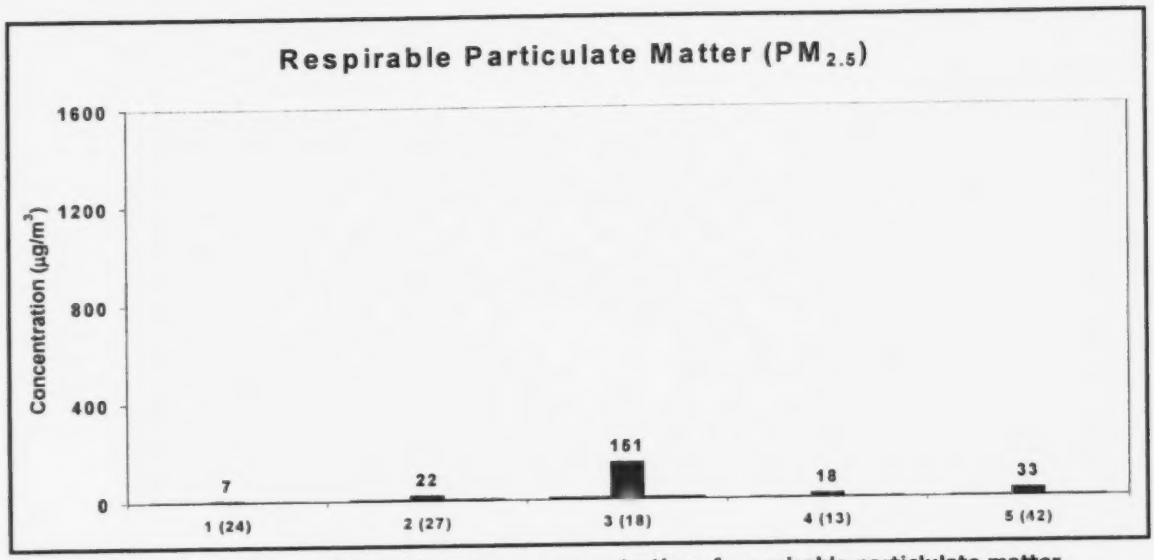


**Figure 18:** **One-hour median and maximum concentrations for repirable particlulate matter.**

# Hydrogen Sulphide and Total Reduced Sulphur ($H_2S$ and TRS)

**Hydrogen sulphide ($H_2S$) is a colourless gas with a rotten egg odour. Total reduced sulphur (TRS) includes hydrogen sulphide, mercaptans, dimethyl sulphide, dimethyl disulphide and other sulphur compounds. Sulphur dioxide is not included in the determination of TRS. Industrial sources of $H_2S$ and TRS include fugitive emissions (leakages) from petroleum refineries, tank farms for unrefined petroleum products, natural gas plants, petrochemical plants, oil sands plants, sewage treatment facilities, pulp and paper plants that use the kraft pulping process, and animal feedlots. Natural sources of $H_2S$ include sulphur hot springs, sloughs, swamps and lakes.**

Both the maximum one-hour TRS and $H_2S$ concentrations of 0.022 ppm and 0.020 ppm were measured at the Husky Refinery site on July 30, 2002. The maximum one-hour $H_2S$ concentration of 0.020 measured at the Husky Refinery exceeded its one-hour AAAQO of 0.010 ppm.

Hydrogen sulphide was significantly above its odour threshold limit for several minutes during the eight measured exceedances of the one-hour AAAQO. Although ambient concentrations of $H_2S$ were above the odour threshold, all concentrations were well below levels known to cause human health effects.

The AAAQO for hydrogen sulphide was exceeded a total of six times at the Husky site and twice at the Greif Containers site. Although hydrogen sulphide exceedances were measured at Greif Containers, hydrogen sulphide detected at this monitoring location likely originated from the upwind Husky Refinery. Hydrogen sulphide is generally not manufactured, processed or otherwise used in Greif Containers' Lloydminster operations.

The overall median concentration of TRS was 0.001 ppm while the median $H_2S$ concentration was below the detection limit of the MAML's analyzer.

The median $H_2S$ and TRS concentrations measured were lower than or similar to those found in other mobile surveys. Maximum concentrations, however, were generally above maximum concentrations measured in other MAML surveys.

Total reduced sulphur concentrations measured at the Husky Refinery site were relatively high compared to hydrogen sulphide; a similar pattern was observed at the Husky Blackfoot Batter #2. From an odour perspective, this suggests that on occasion a significant component of the total reduced sulphur concentration is unidentified, perhaps highly odourous sulphur compounds. Oil refineries processing sulphur compound-rich raw petroleum products may emit substances such as mercaptans and carbon disulphide, which are highly odourous at very low ambient concentrations. Mercaptans and carbon disulphide are two of the many substances included in the MAML's measurement of total reduced sulphur compounds.

Maximum one-hour concentrations for $H_2S$ from other MAML surveys ranged from 0.001 ppm (2000/2001 Wabuman survey) to 0.054 ppm (2001/2002 Bonnyville survey).

Maximum one-hour concentrations for TRS from other MAML surveys ranged from 0.001 ppm (2003 Banff survey) to 0.056 ppm (2001/2002 Cold Lake/Bonnyville survey).

The maximum one-hour concentrations for $H_2S$ and TRS monitored in 2004 at permanent monitoring stations in Alberta were 0.008 ppm (Fort McKay) and 0.036 ppm (Edmonton East), respectively. TRS is not typically monitored at permanent air monitoring stations in Alberta.

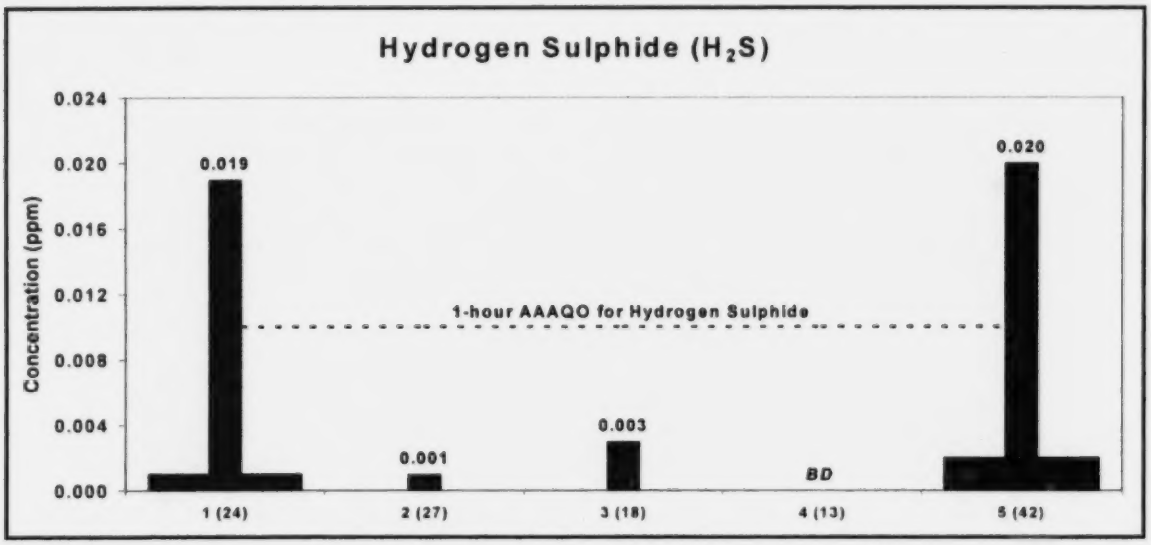


**Figure 19:** **One-hour median and maximum concentrations for hydrogen sulphide**

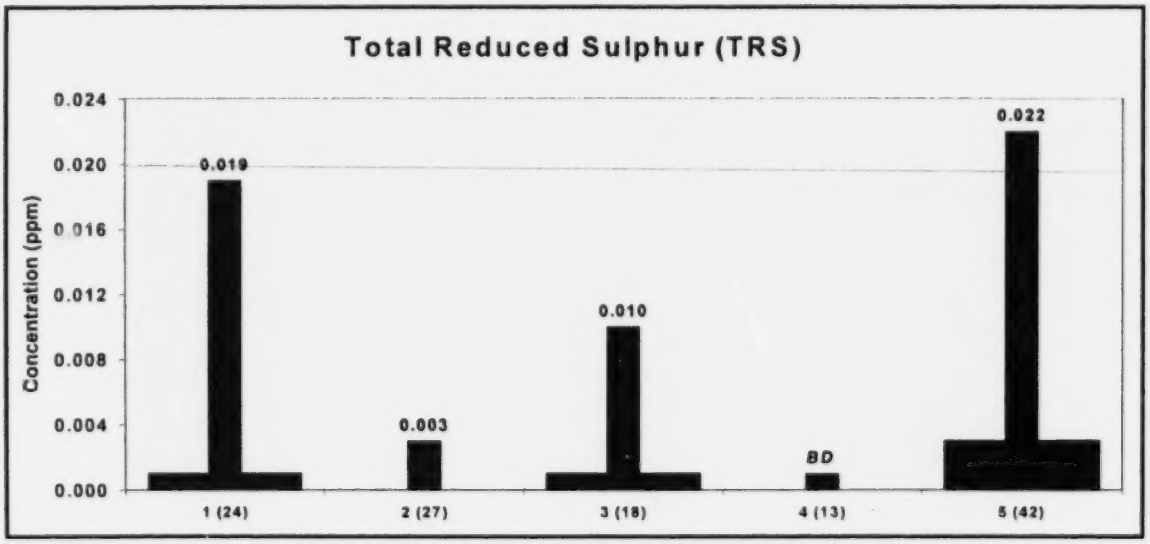


**Figure 20:** **One-hour median and maximum concentrations for total reduced sulphur.**

# Sulphur Dioxide ($SO_2$)

**Sulphur dioxide ($SO_2$) is a colourless gas with a pungent odour. In Alberta, it is estimated that 45% of $SO_2$ emissions are produced by natural gas processing plants while oil sands and power plants produce about 26% and 21% of $SO_2$ emissions, respectively[1]. Other sources include gas plant flares, oil refineries, pulp and paper mills and fertilizer plants.**

$SO_2$ concentrations were well below Alberta's one-hour Objective at all sites monitored in the Lloydminster area.

The maximum $SO_2$ concentration of 0.023 ppm was measured on February 20, 2004 at the ADM Agri-Industries site. This is approximately 13 percent of the Alberta Ambient Air Quality Objective for sulphur dioxide. $SO_2$ measured at this site is not likely produced by AMD Agri-Industries' Lloydminster operations and is perhaps from upwind upstream heavy oil extraction and processing operations.

The overall median concentration of $SO_2$ in the Lloydminster Area survey was 0.002 ppm.

$SO_2$ concentrations measured in the 2002-2004 Lloydminster Area survey were similar to measurements made in previous surveys.

Maximum one-hour sulphur dioxide concentrations in other MAML surveys ranged from 0.002 ppm (2003 Banff survey) to 0.092 ppm (1999/2000 Bow Corridor survey).

In 2004, the maximum one-hour sulphur dioxide concentrations measured at permanent monitoring stations in Alberta ranged from 0.006 ppm (Red Deer) to 0.705 ppm (Mannix).

[1] *Environment Canada. 1998. 1995 Criteria Air Contaminant Emissions Inventory Summaries. Pollution Data Branch, Environment Canada*

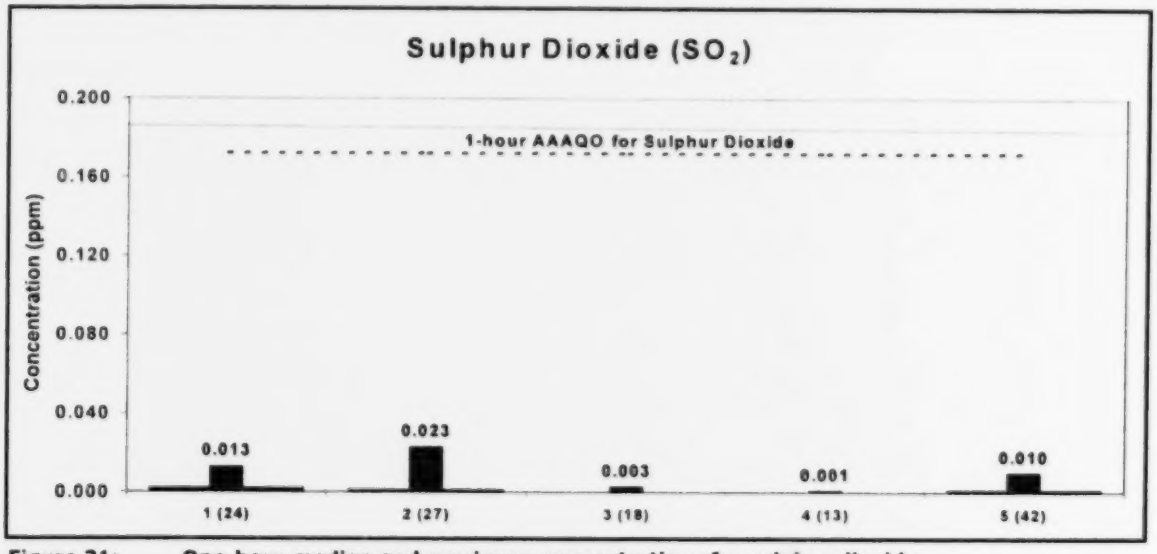


**Figure 21:** **One-hour median and maximum concentrations for sulphur dioxide.**

## Volatile Organic Compounds (VOCs)

**Volatile organic compounds include a large group of chemicals containing carbon and hydrogen atoms that can react quickly to form other chemicals in atmosphere. It should be noted that the terms 'reactive hydrocarbons (RHC)' and 'volatile organic compounds (VOC)' are often used interchangeably and both generally refer to the group of substances that form during combustion and evaporation of solvents and fuels. VOCs are important because they can: (1) react with oxides of nitrogen in the presence of sunlight to form ozone and photochemical smog; and (2) be toxic to humans, animals or vegetation.**

**The major sources of VOCs are vegetation, automobile emissions, gasoline marketing and storage tanks, petroleum and chemical industries, dry cleaning, fireplaces, natural gas combustion and aircraft. VOC emissions from natural sources, such as forests, grasslands and swamps, are estimated to be almost six times greater than human sources. Individual VOCs are also produced from the evaporation of solvents and organic chemicals as well as from leaking valves, flanges, pumps and compressors at industrial facilities. The major source of VOCs in most urban areas is vehicle exhaust emissions.**

During the survey, samples were collected for volatile organic compounds analyses. A total of nine samples were collected at locations upwind and downwind from the Husky Refinery and Greif Containers facilities. After consultation with Alberta Environment's Approvals and Compliance Staff in the Central Region Office, these two facilities were selected for VOC monitoring because of odour complaints and upcoming Alberta Environment Industrial Approval renewals.

Samples were collected using six litre stainless steel electro-polished (SilcoSteel) canisters and were analyzed for more than 150 VOCs. Environment Canada's Environmental Technology Centre in Ottawa conducted the preparation and analysis of the VOC samples. Canister samples were collected on May 15 and October 9, 2002, February 26 and 27, 2003, and February 19, 2004.

One of the goals of collecting canister samples in the Lloydminster Area was to conduct an elementary source apportionment experiment. Source apportionment simply refers to a method of determining contributions of various pollution sources to a location of interest.

The Greif Containers and Husky Refinery facilities are in close proximity to one another; wind direction allowed Alberta Environment to sample VOC emissions from each facility individually as well as cumulatively. Samples were also collected upwind from these two facilities to determine the influence of VOC sources upwind from Lloydminster.

Laboratory analysis revealed that several VOCs were present in low concentrations in Lloydminster. The background sample also indicates that sources upwind from Lloydminster are not significantly contributing to the presence of VOCs in Lloydminster.

Several VOCs reported to the National Pollutant Release Inventory (NPRI) are

included in the suite of compounds that can be detected through laboratory analysis of canister samples. The NPRI was used to make comparisons between VOC concentrations measured in the Lloydminster Area and air emission inventories reported to the NPRI by Greif Containers and the Husky Oil Refinery.

The NPRI provides Canadians with access to information on the releases and transfers of key pollutants in their communities. It is the only national, legislated, publicly accessible inventory of its kind in Canada.

The NPRI is a major starting point for identifying and monitoring sources of pollution in Canada. It is an important consideration in managing risks to the environment and human health as well as in monitoring indicators for the quality of our air, land, and water. It is also emerging as an indicator for corporate environmental performance.

Only facilities that meet established reporting criteria are required to report to the NPRI. Pollutants from mobile sources such as vehicles, households, facilities that release pollutants on a smaller scale and certain sector activities, such as agriculture and education and some mining activities, are not included in the NPRI but may be reported under separate programs.

The Husky Refinery currently reports its annual air emissions inventory to the NPRI. The Lloydminster Greif Containers facility does not report to the NPRI, however, similar Greif operations meet reporting criteria and these facilities' air release inventories are available in the NPRI database.

According to Greif Inc., there are seven major operating sites in Canada including Lloydminster Alberta, Oakville Ontario, and Stoney Creek Ontario; these three sites manufacture plastic and metal drum products. Given that these sites are manufacturing the same products, and assuming that the manufacturing processes are similar, the pollutant release inventories may be comparable.

There are relative similarities between the *quantity* of VOCs reported to the NPRI by Greif's Ontario facilities and the ambient *concentration* of the same VOCs measured downwind from Greif's Lloydminster facility. Similarly, the NPRI air emissions inventory for the Husky Refinery is consistent when comparing the *reported* VOC emissions and *measured* ambient concentrations.

Table 6 presents the 15 VOCs found to be most prevalent in ambient air as *measured* by Alberta Environment in the Lloydminster Area survey. For comparison purposes, also included in Table 6 are the seven most emitted VOCs, as *reported* in tonnes to the NPRI in 2003, by Husky for its Lloydminster Refinery and Greif Containers for its Ontario facilities.

**Table 6:** **Comparison between the 15 VOCs found to be most prevalent in ambient air as measured by Alberta Environment and air emission inventories submitted to Envrionment Canada's NPRI by both Husky for its Lloydminster Refinery and Greif Containers for its Ontario facilities.**

| | 2002, 2003 & 2004 LLOYDMINSTER AMBIENT VOC MONITORING | | | | | | | | | 2003 NPRI INVENTORY | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Target Source Facility** | Greif | none (Upwind) | Greif | Greif | Husky Refinery & Greif | Husky Refinery & Greif | Husky Refinery | Husky Refinery & Greif | Husky Refinery | Greif Stoney Creek | Greif Oakville | Husky Refinery |
| **Sample Date** | 15-May-02 | 15-May-02 | 26-Feb-03 | 26-Feb-03 | 27-Feb-03 | 27-Feb-03 | 9-Oct-02 | 19-Feb-04 | 19-Feb-04 | 2003 Inventory | | |
| **Sample Duration** | 1 hour | 1 hour | 1 hour | 1 minute | 1 minute | 1 hour | 1 minute | 1-hour | 1-hour | annual | annual | annual |
| **Units** | ug/m³ | ug/m³ | ug/m³ | ug/m³ | ug/m³ | ug/m³ | ug/m³ | ug/m³ | ug/m³ | tonnes | tonnes | tonnes |
| Xylenes (all isomers) | 26.22 | 0.21 | 54.86 | 57.33 | 434.14 | 174.25 | 0.74 | 384.88 | 2.59 | 24.52 | 20.26 | 1.24 |
| Toluene | 68.54 | 0.31 | 23.72 | 22.16 | 136.68 | 43.48 | 7.71 | 240.12 | 1.83 | 10.37 | 2.50 | 1.09 |
| Ethylbenzene | 4.99 | 0.05 | 10.34 | 10.43 | 88.65 | 32.84 | 0.17 | 77.92 | 0.50 | 2.62 | 2.06 | 0.26 |
| 2-Butanone (MEK) | ND | ND | 8.15 | 7.69 | 58.86 | 24.44 | 0.60 | ND | ND | 7.44 | 2.96 | |
| Acetone | ND | ND | 7.04 | 4.45 | 9.69 | 7.51 | 2.06 | 38.68 | 8.44 | | | |
| Propane | 1.29 | 0.46 | 4.39 | 4.31 | 7.40 | 7.86 | 1.49 | 9.09 | 9.55 | | | |
| Methanol | ND | ND | 3.90 | 4.16 | 9.47 | 7.56 | 2.91 | 17.16 | 8.28 | | | |
| Freon 12 | 2.57 | 2.78 | 2.90 | 2.95 | 2.90 | 3.00 | 3.05 | 3.73 | 3.97 | | | |
| Acetaldehyde | ND | ND | 4.51 | 2.85 | 3.48 | 3.97 | 1.95 | 4.00 | 4.96 | | | |
| Butane | 0.35 | 0.43 | 2.20 | 1.93 | 7.20 | 6.44 | 3.06 | 7.99 | 7.74 | | | |
| Freon 11 (Trichlorofluoromethane) | 1.76 | 1.90 | 1.74 | 1.78 | 1.77 | 1.82 | 2.05 | 1.82 | 1.94 | | | |
| 2-Methylbutane | 0.28 | 0.40 | 1.89 | 1.74 | 12.93 | 10.45 | 9.77 | 5.37 | 4.37 | | | |
| Isopropyl Alcohol | ND | ND | 1.88 | 1.70 | 7.55 | 3.78 | 0.25 | 68.80 | 0.00 | | 1.69 | |
| Chloromethane | 1.13 | 1.21 | 1.60 | 1.55 | 1.49 | 1.55 | 1.19 | 1.36 | 1.47 | | | 0.21 |
| Hexane | 0.01 | 0.01 | 0.67 | 0.89 | 5.23 | 8.01 | 2.41 | 1.99 | 1.86 | | | 4.33 |

**NOTES:**
ND – Not Determined

Whether an odour has an objectionable effect will depend on the frequency, intensity, duration, offensiveness (or character), and location of the odour event. These factors are collectively known as the FIDOL factors. Although most of the VOCs were found at concentrations below AAAQOs and documented odour thresholds, some individuals are more sensitive than others and may develop transient or short-term effects when exposed to certain odours.

Table 7 presents the maximum 1-hour concentration of selected VOCs measured in Lloydminster, relevant AAAQOs and Texas Effects Screening Levels.

**Table 7:** **Maximum 1-hour concentration of selected VOCs measured in Lloydminster, relevant AAAQOs and Texas Effects Screening Levels (concentrations in ug/m³)**

| | Maximum 1-hour Concentration | One-hour AAAQO | Odour Threshold | | Texas ESL* |
|---|---|---|---|---|---|
| | | | low | high | |
| Acetaldehyde | 4.96 | 90 | 0.2 | 4140 | 90 |
| Acetone | 38.68 | 5900 | 474667 | 1613860 | 5900 |
| Ethylbenzene | 77.92 | 2000 | 8700 | 870000 | 2000 |
| Ethylene Oxide | 0.32 | 15 | 520000 | 1400000 | 20 |
| Isopropyl alcohol | 68.8 | 7850 | 50000 | 500000 | 7850 |
| Methyl ethyl keytone (MEK) | 24.44 | none | 7000 | 251000 | 3900 |
| Styrene | 0.24 | 215 | 160 | 4350 | 110 |
| Toluene | 240.12 | 1880 | 8025 | 150000 | 1880 |
| Total Xylenes (all isomers) | 384.88 | 2300 | 348 | 174000 | 2080 |

**NOTES:**
* If the ambient air concentration of a compound exceeds its corresponding Texas ESL, there is not necessarily an immediate human health issue. An exceedance of an ESL generally triggers an in-depth review to determine possible sources. As can be seen by the similarity between the AAAQOs and ESLs in the above table, several of Alberta Environment's AAAQOs are based on the Texas ESLs. The ESLs listed above are for short-term exposure (1-hour).

# *Appendix A*

Monitoring Data

**Table A1: Median one-hour pollutant concentrations for each site monitored in the Lloydminster Area.**

| | Monitoring Location | | | Hydrocarbons | | | | Oxides of Nitrogen | | | | Particulates | | | Sulphur Compounds | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $NH_3$ | CO | $CH_4$ | RHC | THC | PAH | $NO_2$ | NO | $NO_X$ | $O_3$ | TSP | $PM_{10}$ | $PM_{2.5}$ | $H_2S$ | TRS | $SO_2$ |
| | | ppm | ppm | ppm | ppm | ppm | ng/m³ | ppm | ppm | ppm | ppm | µg/m³ | µg/m³ | µg/m³ | ppm | ppm | ppm |
| 1 | Greif Containers. 5408-52 Avenue | 0.001 | 0.2 | 2.1 | 0.4 | 2.7 | bd | 0.006 | 0.006 | 0.012 | 0.030 | 9 | 6 | 1 | 0.001 | 0.001 | 0.002 |
| 2 | ADM Agri-Industries Ltd. 4805-62 Avenue | 0.003 | 0.2 | 2.3 | 0.2 | 2.5 | 4 | 0.008 | 0.007 | 0.017 | 0.029 | 41 | 26 | 4 | bd | bd | 0.001 |
| 3 | Husky North Blackfoot Battery #2. LSD 13-30-50-1 W4 | 0.002 | 0.1 | 2.5 | 0.7 | 3.0 | 3 | 0.006 | 0.009 | 0.015 | 0.029 | 122 | 71 | 8 | bd | 0.001 | bd |
| 4 | Little Dipper Used Oil Recovery. LSD SW-4-50-1 W4 | 0.002 | 0.1 | 1.9 | 0.2 | 2.1 | bd | 0.004 | 0.005 | 0.011 | 0.034 | 22 | 14 | 2 | bd | bd | bd |
| 5 | Husky Refinery. LSD NW-1-50-1 W4 | bd | 0.2 | 2.2 | bd | 2.3 | bd | 0.006 | 0.005 | 0.013 | 0.030 | 15 | 11 | 2 | 0.002 | 0.003 | 0.001 |

**NOTES:**
ND – not determined (analyzer not functioning)
bd – below detection limit of analyzer

**Table A2: Maximum one-hour pollutant concentrations for each site monitored in the Lloydminster Area.**

| | Monitoring Location | | | Hydrocarbons | | | | Oxides of Nitrogen | | | | Particulates | | | Sulphur Compounds | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $NH_3$ | CO | $CH_4$ | RHC | THC | PAH | $NO_2$ | NO | $NO_X$ | $O_3$ | TSP | $PM_{10}$ | $PM_{2.5}$ | $H_2S$ | TRS | $SO_2$ |
| | | ppm | ppm | ppm | ppm | ppm | ng/m³ | ppm | ppm | ppm | ppm | µg/m³ | µg/m³ | µg/m³ | ppm | ppm | ppm |
| 1 | Greif Containers. 5408-52 Avenue | 0.009 | 0.7 | 3.9 | 2.9 | 5.1 | 27 | 0.021 | 0.022 | 0.043 | 0.039 | 88 | 57 | 7 | 0.019 | 0.019 | 0.013 |
| 2 | ADM Agri-Industries Ltd. 4805-62 Avenue | 0.016 | 0.8 | 4.9 | 1.1 | 5.0 | 11 | 0.038 | 0.038 | 0.062 | 0.040 | 222 | 152 | 22 | 0.001 | 0.003 | 0.003 |
| 3 | Husky North Blackfoot Battery #2. LSD 13-30-50-1 W4 | 0.006 | 0.3 | 4.3 | 1.7 | 5.2 | 12 | 0.011 | 0.016 | 0.027 | 0.042 | 1418 | 946 | 151 | 0.003 | 0.010 | 0.003 |
| 4 | Little Dipper Used Oil Recovery. LSD SW-4-50-1 W4 | 0.008 | 0.2 | 2.9 | 0.3 | 3.0 | 7 | 0.008 | 0.011 | 0.017 | 0.041 | 408 | 220 | 18 | 0.000 | 0.001 | 0.001 |
| 5 | Husky Refinery. LSD NW-1-50-1 W4 | 0.006 | 0.7 | 3.9 | 0.4 | 3.9 | 21 | 0.024 | 0.020 | 0.044 | 0.043 | 425 | 282 | 33 | 0.020 | 0.022 | 0.010 |

**NOTES:**
ND – not determined (analyzer not functioning)
bd – below detection limit of analyzer

**Table A3: Median one-hour air pollutant concentrations in Alberta.**

| Air Quality Station or Survey Name | Station or Survey Type | Monitoring Period | CO ppm | $O_3$ ppm | THC ppm | $CH_4$ ppm | RHC ppm | $SO_2$ ppm | $NO_2$ ppm | $NH_3$ ppm | TRS ppm | $H_2S$ ppm | TSP µg/m³ | $PM_{10}$ µg/m³ | $PM_{2.5}$ µg/m³ | PAHs ng/m³ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lloydminster (current survey) | mobile survey | Jan. 2002 to Nov. 2004 | 0.2 | 0.030 | 2.5 | 2.2 | 0.2 | 0.001 | 0.006 | 0.001 | 0.001 | bd | 19 | 13 | 2 | 3 |
| Lakeland Area[1] | mobile survey | May 2003 to Sep. 2004 | 0.2 | 0.031 | 2.6 | 2.4 | 0.2 | bd | 0.002 | 0.002 | bd | bd | 14 | 9 | 1 | bd |
| Banff[1] | mobile survey | Nov. 19 to 22, 2003 | 0.5 | 0.018 | 2.7 | 2.5 | 0.2 | 0.000 | 0.008 | 0.004 | 0.000 | 0.001 | 7 | 5 | 1 | 11 |
| Fort Saskatchewan/Redwater1 | mobile survey | May 2001 to Mar. 2002 | 0.3 | 0.029 | 2.1 | 2.1 | 0.1 | 0.001 | 0.004 | 0.001 | bd | bd | 39 | 22 | 3 | bd |
| Cold Lake/Bonnieville/Elk Point[1] | mobile survey | Mar. 2001 to Feb. 2002 | 0.2 | 0.031 | 2.1 | 1.9 | 0.1 | 0.000 | 0.003 | 0.000 | 0.001 | 0.000 | 16 | 10 | 2 | 1 |
| Whitecourt/Swan Hills/Shiningbank Lake[1] | mobile survey | Mar. 2001 to June 2001 | 0.2 | 0.027 | 2.3 | 2.0 | 0.3 | 0.004 | 0.005 | 0.001 | 0.001 | 0.000 | 47 | 29 | 4 | 1 |
| Wabuman[1] | mobile survey | July 2000 to Sep. 2001 | 0.2 | 0.027 | 2.0 | 1.9 | 0.1 | 0.002 | 0.005 | 0.004 | 0.000 | 0.000 | 34 | 22 | 3 | 1 |
| Edmonton (Whitemud Drive)[1] | mobile survey | June 2000 to July 2001 | 0.4 | 0.019 | 2.2 | 2.0 | 0.1 | 0.002 | 0.014 | 0.00 | 0.000 | 0.000 | 41 | 24 | 3 | 8 |
| Bow Corridor[1] | mobile survey | Dec. 1999 to Sep. 2000 | 0.2 | 0.030 | 1.9 | 1.8 | 0.1 | 0.001 | 0.007 | 0.001 | 0.001 | 0.000 | 74 | 40 | 4 | 4 |
| **Permanent Continuous Monitoring Stations** | | | | | | | | | | | | | | | | |
| Beaverlodge[2] | rural | Jan. 2004 to Dec. 2004 | n/a | 0.031 | n/a | n/a | n/a | bd | 0.003 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Calgary Central[2] | urban | Jan. 2004 to Dec. 2004 | 0.4 | 0.014 | 2.0 | n/a | n/a | n/a | 0.023 | n/a | n/a | n/a | n/a | 19 | 5 | n/a |
| Calgary East[2] | urban | Jan. 2004 to Dec. 2004 | 0.4 | 0.015 | 2.2 | n/a | n/a | 0.001 | 0.020 | n/a | n/a | 0.001 | n/a | n/a | 6 | n/a |
| Calgary Northwest[2] | urban | Jan. 2004 to Dec. 2004 | 0.3 | 0.022 | 2.0 | n/a | n/a | n/a | 0.015 | n/a | n/a | n/a | n/a | n/a | 4 | n/a |
| Edmonton Central[2] | urban | Jan. 2004 to Dec. 2004 | 0.4 | 0.015 | 2.1 | n/a | n/a | n/a | 0.020 | n/a | n/a | n/a | n/a | n/a | 5 | n/a |
| Edmonton East[2] | urban | Jan. 2004 to Dec. 2004 | 0.0 | 0.021 | 2.3 | n/a | n/a | 0.001 | 0.018 | n/a | n/a | bd | n/a | n/a | 4 | n/a |
| Edmonton Northwest[2] | urban | Jan. 2004 to Dec. 2004 | 0.3 | 0.018 | 2.0 | n/a | n/a | n/a | 0.014 | n/a | n/a | n/a | n/a | 17 | 4 | n/a |
| Fort Saskatchewan[2] | small urban | Jan. 2004 to Dec. 2004 | 3.1 | 0.022 | 1.9 | n/a | n/a | 0.001 | 0.007 | 0.002 | n/a | bd | n/a | n/a | 3 | n/a |
| Red Deer[2] | small urban | Jan. 2004 to Dec. 2004 | 0.3 | 0.019 | 1.9 | n/a | n/a | bd | 0.006 | n/a | n/a | bd | n/a | n/a | 4 | n/a |
| Buffalo Viewpoint[3] | industrial | Jan. 2004 to Dec. 2004 | n/a | n/a | 1.9 | n/a | n/a | bd | n/a | n/a | n/a | bd | n/a | n/a | n/a | n/a |
| Fort Chipewyan[3] | rural | Jan. 2004 to Dec. 2004 | n/a | 0.023 | n/a | n/a | n/a | bd | 0.038 | n/a | n/a | n/a | n/a | n/a | 2 | n/a |
| Fort McKay[3] | rural | Jan. 2004 to Dec. 2004 | n/a | 0.023 | 1.8 | n/a | n/a | bd | 0.003 | n/a | bd | n/a | n/a | n/a | 2 | n/a |
| Fort McMurray (Athabasca Valley)[3] | small urban | Jan. 2004 to Dec. 2004 | 0.2 | 0.020 | 3.5 | n/a | n/a | bd | 0.007 | n/a | 0.001 | n/a | n/a | n/a | 2 | n/a |
| Fort McMurray (Patricia McInnes)[3] | small urban | Jan. 2004 to Dec. 2004 | n/a | 0.022 | 1.9 | n/a | n/a | 0.001 | 0.004 | n/a | bd | n/a | n/a | n/a | 3 | n/a |
| Mannix[3] | industrial | Jan. 2004 to Dec. 2004 | n/a | n/a | 1.9 | n/a | n/a | 0.001 | n/a | n/a | n/a | bd | n/a | n/a | n/a | n/a |
| Mildred Lake[3] | industrial | Jan. 2004 to Dec. 2004 | n/a | n/a | 1.9 | n/a | n/a | bd | n/a | n/a | n/a | bd | n/a | n/a | n/a | n/a |
| Carrot Creek[4] | rural | Jan. 2004 to Dec. 2004 | n/a | 0.029 | n/a | n/a | n/a | bd | 0.004 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Hightower Ridge[4] | background | Jan. 2004 to Dec. 2004 | n/a | 0.045 | n/a | n/a | n/a | bd | 0.001 | n/a | n/a | n/a | n/a | 5 | 1 | n/a |
| Tomahawk[4] | rural | Jan. 2004 to Dec. 2004 | n/a | 0.030 | n/a | n/a | n/a | 0.001 | 0.003 | n/a | n/a | n/a | n/a | 9 | 3 | n/a |
| Violet Grove[4] | rural | Jan. 2004 to Dec. 2004 | n/a | 0.034 | 2.0 | n/a | n/a | 0.001 | 0.002 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Caroline[6] | rural | Jan. 2004 to Dec. 2004 | n/a | 0.026 | 2.2 | n/a | n/a | bd | 0.002 | n/a | bd | n/a | n/a | n/a | n/a | n/a |

**NOTES:**

1 – Mobile survey conducted by Alberta Environment.
2 – Station operated by Alberta Environment.
3 – Station operated by the Wood Buffalo Environmental Association.
4 – Station operated by the West Central Airshed Society.
5 – Station operated by the Strathcona Industrial Association.
6 – Station operated by the Parkland Airshed Management Association.

n/a – Parameter not monitored or data not available.
bd – Below lower detection limit of analyzer

**Table A4: Maximum one-hour air pollutant concentrations in Alberta.**

| Air Quality Station or Survey Name | Station or Survey Type | Monitoring Period | CO ppm | $O_3$ ppm | THC ppm | $CH_4$ ppm | RHC ppm | $SO_2$ ppm | $NO_2$ ppm | $NH_3$ ppm | TRS ppm | $H_2S$ ppm | TSP µg/m³ | $PM_{10}$ µg/m³ | $PM_{2.5}$ µg/m³ | PAHs ng/m³ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lloydminster (current survey) | mobile survey | Jan. 2002 to Nov. 2004 | 0.8 | 0.043 | 5.2 | 4.9 | 2.9 | 0.023 | 0.038 | 0.016 | 0.022 | 0.020 | 1418 | 946 | 151 | 27 |
| Lakeland Area[1] | mobile survey | May 2003 to Sep. 2004 | 0.9 | 0.049 | 7.2 | 4.1 | 4.6 | 0.009 | 0.012 | 0.013 | 0.003 | 0.003 | 1505 | 1074 | 127 | 14 |
| Banff[1] | mobile survey | Nov. 19 to 22, 2003 | 1.5 | 0.034 | 3.6 | 3.1 | 0.8 | 0.002 | 0.033 | 0.013 | 0.001 | 0.003 | 37 | 23 | 21 | 105 |
| Fort Saskatchewan/Redwater[1] | mobile survey | May 2001 to Mar. 2002 | 2.2 | 0.049 | 3.6 | 3.6 | 0.5 | 0.022 | 0.051 | 0.577 | 0.004 | 0.003 | 547 | 323 | 24 | 70 |
| Cold Lake/Bonnieville/Elk Point[1] | mobile survey | Mar. 2001 to Feb. 2002 | 1.4 | 0.047 | 9.7 | 4.6 | 7.1 | 0.017 | 0.014 | 0.005 | 0.056 | 0.054 | 2281 | 1188 | 72 | 14 |
| Whitecourt/Swan Hills/Shiningbank Lake[1] | mobile survey | Mar. 2001 to June 2001 | 0.7 | 0.054 | 4.3 | 2.5 | 2.5 | 0.046 | 0.030 | 0.013 | 0.005 | 0.003 | 946 | 441 | 43 | 113 |
| Waburnan[1] | mobile survey | July 2000 to Sep. 2001 | 0.5 | 0.057 | 3.3 | 3.2 | 0.5 | 0.032 | 0.015 | 0.020 | 0.003 | 0.001 | 807 | 534 | 42 | 11 |
| Edmonton (Whitemud Drive)[1] | mobile survey | June 2000 to July 2001 | 2.7 | 0.059 | 4.4 | 2.7 | 1.6 | 0.015 | 0.041 | 0.039 | 0.005 | 0.003 | 459 | 239 | 37 | 77 |
| Bow Corridor[1] | mobile survey | Dec. 1999 to Sep. 2000 | 1.1 | 0.056 | 7.8 | 2.2 | 5.6 | 0.092 | 0.031 | 0.034 | 0.004 | 0.002 | 2082 | 1094 | 60 | 36 |
| **Permanent Continuous Monitoring Stations** | | | | | | | | | | | | | | | | |
| Beaverlodge[2] | rural | Jan. 2004 to Dec. 2004 | n/a | 0.065 | n/a | n/a | n/a | 0.037 | 0.045 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Calgary Central[2] | urban | Jan. 2004 to Dec. 2004 | 5.1 | 0.061 | 3.6 | n/a | n/a | n/a | 0.088 | n/a | n/a | n/a | n/a | 269 | 48 | n/a |
| Calgary East[2] | urban | Jan. 2004 to Dec. 2004 | 4.2 | 0.070 | 4.6 | n/a | n/a | 0.032 | 0.108 | n/a | n/a | 0.025 | n/a | n/a | 97 | n/a |
| Calgary Northwest[2] | urban | Jan. 2004 to Dec. 2004 | 3.8 | 0.073 | 3.4 | n/a | n/a | n/a | 0.076 | n/a | n/a | n/a | n/a | n/a | 46 | n/a |
| Edmonton Central[2] | urban | Jan. 2004 to Dec. 2004 | 4.2 | 0.079 | 9.5 | n/a | n/a | n/a | 0.072 | n/a | n/a | n/a | n/a | n/a | 100 | n/a |
| Edmonton East[2] | urban | Jan. 2004 to Dec. 2004 | 2.3 | 0.092 | 25.9 | n/a | n/a | 0.053 | 0.081 | n/a | n/a | 0.036 | n/a | n/a | 90 | n/a |
| Edmonton Northwest[2] | urban | Jan. 2004 to Dec. 2004 | 6.6 | 0.073 | 14.5 | n/a | n/a | n/a | 0.082 | n/a | n/a | n/a | n/a | 223 | 103 | n/a |
| Fort Saskatchewan[2] | small urban | Jan. 2004 to Dec. 2004 | 3.1 | 0.074 | 4.6 | n/a | n/a | 0.027 | 0.066 | 0.141 | n/a | 0.005 | n/a | n/a | 124 | n/a |
| Red Deer[2] | small urban | Jan. 2004 to Dec. 2004 | 2.4 | 0.070 | 16.9 | n/a | n/a | 0.006 | 0.055 | n/a | n/a | 0.010 | n/a | n/a | 87 | n/a |
| Buffalo Viewpoint[3] | industrial | Jan. 2004 to Dec. 2004 | n/a | n/a | 6.6 | n/a | n/a | 0.178 | n/a | n/a | n/a | 0.016 | n/a | n/a | n/a | n/a |
| Fort Chipewyan[3] | rural | Jan. 2004 to Dec. 2004 | n/a | 0.070 | n/a | n/a | n/a | 0.086 | 0.038 | n/a | n/a | n/a | n/a | n/a | 75 | n/a |
| Fort McKay[3] | rural | Jan. 2004 to Dec. 2004 | n/a | 0.070 | n/a | n/a | n/a | 0.086 | 0.038 | n/a | 0.008 | n/a | n/a | n/a | 75 | n/a |
| Fort McMurray (Athabasca Valley)[3] | small urban | Jan. 2004 to Dec. 2004 | 1.9 | 0.065 | 3.5 | n/a | n/a | 0.077 | 0.183 | n/a | 0.006 | n/a | n/a | n/a | 189 | n/a |
| Fort McMurray (Patricia McInnes)[3] | small urban | Jan. 2004 to Dec. 2004 | n/a | 0.057 | 6.0 | n/a | n/a | 0.103 | 0.045 | n/a | 0.003 | n/a | n/a | n/a | 86 | n/a |
| Mannix[3] | industrial | Jan. 2004 to Dec. 2004 | n/a | n/a | 7.2 | n/a | n/a | 0.705 | n/a | n/a | n/a | 0.015 | n/a | n/a | n/a | n/a |
| Mildred Lake[3] | industrial | Jan. 2004 to Dec. 2004 | n/a | n/a | 9.1 | n/a | n/a | 0.173 | n/a | n/a | n/a | 0.033 | n/a | n/a | n/a | n/a |
| Carrot Creek[4] | rural | Jan. 2004 to Dec. 2004 | n/a | 0.080 | n/a | n/a | n/a | 0.054 | 0.047 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Hightower Ridge[4] | background | Jan. 2004 to Dec. 2004 | n/a | 0.077 | n/a | n/a | n/a | 0.012 | 0.025 | n/a | n/a | n/a | n/a | 80 | 73 | n/a |
| Tomahawk[4] | rural | Jan. 2004 to Dec. 2004 | n/a | 0.070 | n/a | n/a | n/a | 0.025 | 0.058 | n/a | n/a | n/a | n/a | 171 | 50 | n/a |
| Violet Grove[4] | rural | Jan. 2004 to Dec. 2004 | n/a | 0.068 | 9.0 | n/a | n/a | 0.030 | 0.046 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Caroline[6] | rural | Jan. 2004 to Dec. 2004 | n/a | 0.061 | 3.4 | n/a | n/a | 0.026 | 0.028 | n/a | 0.004 | n/a | n/a | n/a | n/a | n/a |

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6 - Station operated by the Parkland Airshed Management Association.

n/a - Parameter not monitored or data not available.
bd - Below lower detection limit of analyzer

**Table A5: Chronological listing of one-hour average concentrations (by site).**

| Site | Date | Time (MST) | CO ppm | $NH_3$ ppm | $CH_4$ ppm | RHC ppm | THC ppm | PAH ng/m³ | $NO_2$ ppm | NO ppm | $NO_x$ ppm | $O_3$ ppm | TSP µg/m³ | $PM_{10}$ µg/m³ | $PM_{2.5}$ µg/m³ | $H_2S$ ppm | TRS ppm | $SO_2$ ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site 1 Grad Containers | 15-May-02 | 13:25 to 14:26 | bd | 0.001 | 1.7 | 0.4 | 2.1 | bd | 0.002 | 0.003 | 0.005 | 0.030 | 51 | 30 | 4 | bd | bd | bd |
| | 15-May-02 | 14:28 to 15:29 | bd | 0.001 | 1.9 | 0.2 | 2.1 | bd | 0.002 | 0.002 | 0.004 | 0.039 | 57 | 39 | 4 | bd | bd | bd |
| | 29-Jul-02 | 12:09 to 13:09 | 0.4 | bd | 2.1 | 2.9 | 5.0 | 3 | 0.011 | 0.010 | 0.021 | 0.002 | 6 | 4 | 1 | 0.012 | 0.012 | 0.013 |
| | 29-Jul-02 | 15:30 to 16:30 | 0.1 | bd | 1.3 | 0.4 | 2.3 | bd | 0.003 | 0.003 | 0.006 | 0.030 | 7 | 4 | 1 | 0.003 | 0.003 | 0.002 |
| | 30-Jul-02 | 09:19 to 10:19 | 0.1 | bd | 1.9 | 0.8 | 2.7 | bd | 0.007 | 0.006 | 0.013 | 0.024 | 9 | 6 | 1 | 0.002 | 0.003 | 0.002 |
| | 30-Jul-02 | 10:24 to 11:24 | 0.1 | bd | 1.8 | 1.0 | 2.8 | 3 | 0.007 | 0.006 | 0.013 | 0.024 | 8 | 6 | 1 | 0.010 | 0.012 | 0.002 |
| | 30-Jul-02 | 16:18 to 17:18 | bd | bd | 2.0 | 0.3 | 2.3 | 3 | 0.003 | 0.001 | 0.004 | 0.035 | 11 | 6 | 1 | 0.001 | 0.001 | bd |
| | 31-Jul-02 | 09:14 to 10:14 | 0.2 | bd | 1.7 | 0.3 | 2.0 | 4 | 0.003 | 0.006 | 0.009 | 0.010 | 16 | 10 | 1 | 0.002 | 0.002 | 0.001 |
| | 7-Oct-02 | 12:18 to 13:18 | 0.3 | bd | 2.6 | 0.1 | 2.6 | 4 | 0.004 | 0.007 | 0.011 | 0.022 | 3 | 2 | bd | bd | bd | bd |
| | 8-Oct-02 | 12:56 to 13:56 | 0.3 | bd | 2.0 | 0.2 | 2.2 | bd | 0.004 | 0.004 | 0.008 | 0.030 | 7 | 5 | 1 | bd | bd | 0.001 |
| | 9-Oct-02 | 11:17 to 12:17 | 0.3 | bd | 2.0 | 0.2 | 2.2 | 3 | 0.005 | 0.003 | 0.008 | 0.037 | 5 | 3 | 1 | bd | bd | 0.001 |
| | 26-Feb-03 | 13:40 to 14:40 | 0.3 | 0.001 | 3.9 | 0.1 | 4.0 | ND | 0.010 | 0.005 | 0.015 | 0.039 | 1 | 1 | bd | 0.001 | bd | 0.003 |
| | 27-Feb-03 | 12:39 to 13:39 | 0.3 | 0.001 | 2.9 | 2.2 | 5.1 | bd | 0.008 | 0.011 | 0.019 | 0.034 | 4 | 3 | 2 | 0.019 | 0.019 | 0.008 |
| | 19-Feb-04 | 09:53 to 10:45 | 0.2 | 0.007 | 2.2 | 1.9 | 4.1 | na | 0.014 | 0.012 | 0.026 | 0.029 | 5 | 3 | 1 | 0.003 | 0.003 | 0.005 |
| | 19-Feb-04 | 10:45 to 11:45 | 0.2 | 0.009 | 2.1 | 1.1 | 3.2 | bd | 0.012 | 0.010 | 0.022 | 0.030 | 4 | 3 | 1 | 0.003 | 0.003 | 0.003 |
| | 19-Feb-04 | 14:45 to 15:45 | 0.2 | 0.005 | 2.0 | 1.1 | 3.1 | bd | 0.009 | 0.008 | 0.017 | 0.034 | 3 | 2 | 1 | 0.003 | 0.003 | 0.003 |
| | 20-Feb-04 | 09:52 to 10:52 | 0.7 | 0.003 | 2.6 | 0.2 | 2.7 | 19 | 0.010 | 0.009 | 0.019 | 0.005 | 4 | 2 | 1 | 0.004 | 0.004 | 0.005 |
| | 20-May-04 | 14:27 to 15:27 | 0.1 | 0.001 | 2.4 | bd | 2.4 | bd | 0.002 | 0.002 | 0.004 | 0.009 | 78 | 42 | 5 | bd | bd | 0.001 |
| | 5-Aug-04 | 14:14 to 15:14 | 0.3 | 0.002 | 2.2 | 1.6 | 3.8 | bd | 0.003 | 0.003 | 0.006 | 0.035 | 37 | 26 | 4 | bd | 0.001 | 0.001 |
| | 6-Aug-04 | 08:53 to 09:53 | 0.3 | 0.001 | 2.2 | 0.9 | 3.1 | bd | 0.003 | 0.005 | 0.008 | 0.035 | 19 | 15 | 3 | 0.001 | 0.001 | 0.003 |
| | 25-Nov-04 | 09:52 to 10:52 | bd | 0.001 | 2.1 | 0.8 | 2.9 | 6 | 0.009 | 0.008 | 0.017 | 0.016 | 14 | 9 | 1 | bd | bd | 0.003 |
| | 25-Nov-04 | 10:52 to 11:52 | 0.1 | bd | 2.1 | 0.2 | 2.3 | 3 | 0.005 | 0.005 | 0.010 | 0.021 | 14 | 9 | 1 | bd | bd | 0.002 |
| | 25-Nov-04 | 15:40 to 16:40 | 0.4 | 0.003 | 2.1 | 0.4 | 2.5 | 27 | 0.021 | 0.022 | 0.043 | 0.011 | 88 | 57 | 7 | 0.001 | 0.001 | 0.002 |
| | 26-Nov-04 | 10:19 to 11:19 | 0.1 | 0.001 | 2.3 | 0.5 | 2.8 | bd | 0.006 | 0.006 | 0.012 | 0.017 | 28 | 18 | 3 | bd | bd | bd |
| Site 2 ADM Agri-Industries | 14-May-02 | 17:13 to 18:14 | 0.2 | 0.002 | 2.1 | 0.2 | 2.3 | bd | 0.003 | 0.002 | 0.005 | 0.031 | 64 | 42 | 6 | bd | bd | 0.002 |
| | 15-May-02 | 11:54 to 12:55 | bd | 0.003 | 1.6 | 0.3 | 1.9 | 5 | 0.007 | 0.007 | 0.014 | 0.035 | 84 | 51 | 6 | bd | bd | bd |
| | 15-May-02 | 16:57 to 17:58 | 0.1 | 0.004 | 2.0 | 0.2 | 2.2 | 6 | 0.003 | 0.009 | 0.012 | 0.039 | 219 | 140 | 13 | bd | bd | bd |
| | 16-May-02 | 11:03 to 12:04 | 0.2 | 0.016 | 1.6 | 0.3 | 1.9 | 4 | 0.004 | 0.019 | 0.023 | 0.040 | 94 | 59 | 7 | bd | bd | 0.001 |
| | 8-Oct-02 | 11:38 to 12:38 | 0.2 | 0.003 | 2.0 | 0.1 | 2.1 | 4 | 0.011 | 0.015 | 0.026 | 0.019 | 10 | 6 | 1 | bd | 0.001 | 0.001 |
| | 8-Oct-02 | 18:17 to 19:17 | 0.3 | 0.002 | 2.3 | 1.1 | 3.4 | 7 | 0.018 | 0.006 | 0.023 | 0.018 | 7 | 5 | 1 | bd | bd | bd |
| | 9-Oct-02 | 08:30 to 09:30 | 0.3 | 0.004 | 2.3 | 0.1 | 2.4 | 7 | 0.011 | 0.007 | 0.018 | 0.021 | 33 | 22 | 4 | bd | bd | 0.001 |
| | 26-Feb-03 | 16:51 to 17:51 | 0.8 | 0.003 | 4.9 | 0.1 | 5.0 | ND | 0.038 | 0.024 | 0.062 | 0.017 | 4 | 2 | bd | 0.001 | 0.001 | 0.003 |
| | 27-Feb-03 | 14:04 to 15:04 | 0.6 | 0.007 | 2.8 | 0.4 | 3.2 | bd | 0.009 | 0.011 | 0.020 | 0.033 | 2 | 1 | bd | 0.001 | 0.002 | 0.005 |
| | 27-Feb-03 | 18:14 to 19:14 | 0.7 | 0.004 | 3.0 | 0.6 | 3.6 | 11 | 0.035 | 0.024 | 0.059 | 0.013 | 2 | 1 | 1 | 0.001 | 0.002 | 0.002 |
| | 28-Feb-03 | 10:41 to 11:41 | 0.6 | 0.001 | 2.9 | bd | 2.9 | 5 | 0.019 | 0.012 | 0.019 | 0.000 | 3 | 2 | 1 | bd | bd | 0.003 |
| | 18-Feb-04 | 08:44 to 09:44 | 0.3 | 0.003 | 2.8 | bd | 2.8 | 5 | 0.012 | 0.009 | 0.021 | 0.022 | 2 | 1 | 1 | 0.001 | 0.002 | 0.017 |
| | 19-Feb-04 | 17:23 to 18:23 | 0.1 | 0.007 | 1.9 | 0.4 | 2.3 | bd | 0.007 | 0.007 | 0.014 | 0.032 | 3 | 1 | bd | bd | bd | 0.008 |
| | 20-Feb-04 | 08:42 to 09:42 | 0.1 | 0.004 | 2.2 | 0.1 | 2.3 | bd | 0.008 | 0.036 | 0.046 | 0.032 | 6 | 4 | 1 | bd | bd | 0.002 |
| | 20-Feb-04 | 18:23 to 19:23 | 0.5 | 0.004 | 2.2 | 0.5 | 2.7 | bd | 0.009 | 0.008 | 0.017 | 0.029 | 4 | 3 | 1 | 0.001 | 0.001 | 0.023 |
| | 19-May-04 | 13:15 to 14:15 | 0.1 | 0.002 | 2.9 | 0.1 | 3.0 | bd | 0.008 | 0.009 | 0.017 | 0.037 | 46 | 31 | 4 | 0.001 | 0.001 | 0.003 |
| | 20-May-04 | 08:10 to 09:10 | 0.1 | 0.001 | 2.4 | 0.1 | 2.5 | 3 | 0.010 | 0.010 | 0.020 | 0.037 | 75 | 44 | 6 | 0.001 | 0.001 | 0.001 |
| | 20-May-04 | 16:11 to 17:11 | 0.1 | bd | 2.3 | 0.2 | 2.5 | bd | 0.005 | 0.003 | 0.008 | 0.040 | 32 | 21 | 3 | bd | bd | 0.001 |
| | 21-May-04 | 11:43 to 12:43 | 0.2 | 0.004 | 2.7 | 0.1 | 2.8 | 9 | 0.012 | 0.017 | 0.029 | 0.033 | 151 | 96 | 11 | bd | 0.001 | 0.003 |
| | 4-Aug-04 | 12:58 to 13:58 | 0.3 | 0.001 | 2.2 | 0.1 | 2.3 | 10 | 0.006 | 0.006 | 0.012 | 0.029 | 220 | 152 | 22 | bd | bd | 0.001 |
| | 5-Aug-04 | 10:04 to 11:04 | 0.2 | 0.001 | 2.4 | bd | 2.4 | 5 | 0.003 | 0.003 | 0.006 | 0.026 | 62 | 39 | 5 | bd | bd | 0.001 |
| | 5-Aug-04 | 16:43 to 17:43 | 0.2 | bd | 2.0 | 0.3 | 2.3 | 10 | 0.003 | 0.002 | 0.005 | 0.035 | 55 | 32 | 4 | bd | bd | bd |
| | 6-Aug-04 | 18:01 to 19:01 | 0.4 | 0.003 | 2.2 | 0.6 | 2.8 | 3 | 0.010 | 0.007 | 0.017 | 0.031 | 29 | 17 | 3 | 0.001 | 0.003 | 0.001 |
| | 24-Nov-04 | 16:45 to 17:45 | bd | 0.002 | 2.9 | 0.1 | 3.0 | 3 | 0.012 | 0.005 | 0.017 | 0.019 | 222 | 105 | 8 | bd | bd | 0.002 |
| | 25-Nov-04 | 17:49 to 18:49 | 0.1 | 0.003 | 2.1 | 0.4 | 2.5 | 4 | 0.008 | 0.007 | 0.013 | 0.022 | 86 | 46 | 4 | bd | bd | 0.004 |
| | 26-Nov-04 | 12:15 to 13:15 | 0.1 | 0.001 | 2.2 | bd | 2.2 | bd | 0.005 | 0.004 | 0.009 | 0.022 | 41 | 26 | 3 | bd | 0.001 | 0.003 |
| | 26-Nov-04 | 13:46 to 14:46 | 0.1 | 0.004 | 2.7 | 0.1 | 2.8 | 3 | 0.006 | 0.003 | 0.009 | 0.018 | 59 | 34 | 4 | bd | bd | bd |
| Site 3 Husky North Blackfoot Battery #2 | 14-May-02 | 11:42 to 12:43 | bd | 0.003 | 2.0 | 0.8 | 2.8 | 5 | 0.003 | 0.005 | 0.008 | 0.032 | 1271 | 946 | 151 | 0.001 | 0.010 | bd |
| | 15-May-02 | 09:22 to 10:23 | bd | 0.003 | 1.7 | 1.1 | 2.8 | 5 | 0.004 | 0.009 | 0.013 | 0.032 | 1167 | 860 | 102 | bd | bd | bd |
| | 15-May-02 | 10:22 to 11:23 | bd | 0.002 | 1.6 | 0.5 | 2.1 | bd | 0.003 | 0.005 | 0.008 | 0.034 | 309 | 225 | 20 | bd | bd | bd |
| | 16-May-02 | 09:27 to 10:28 | 0.2 | 0.006 | 1.8 | 0.3 | 2.1 | bd | 0.005 | 0.009 | 0.014 | 0.005 | 1418 | 902 | 87 | bd | bd | bd |
| | 29-Jul-02 | 17:05 to 18:05 | 0.1 | 0.001 | 2.1 | bd | 2.1 | bd | 0.002 | bd | 0.002 | 0.035 | 36 | 25 | 4 | bd | bd | bd |
| | 7-Oct-02 | 17:22 to 18:22 | 0.2 | bd | 2.5 | bd | 2.5 | bd | 0.002 | 0.001 | 0.003 | 0.028 | 5 | 3 | bd | bd | 0.001 | bd |
| | 8-Oct-02 | 08:54 to 09:54 | 0.3 | 0.001 | 2.5 | 1.4 | 3.9 | 8 | 0.006 | 0.011 | 0.017 | 0.018 | 4 | 2 | 1 | bd | 0.003 | bd |
| | 8-Oct-02 | 09:54 to 10:54 | 0.3 | 0.001 | 2.7 | 1.7 | 4.4 | 12 | 0.009 | 0.013 | 0.022 | 0.018 | 4 | 2 | bd | 0.001 | 0.003 | bd |
| | 8-Oct-02 | 16:55 to 17:55 | 0.2 | bd | 2.1 | bd | 2.1 | bd | 0.009 | 0.004 | 0.013 | 0.026 | 7 | 5 | 1 | bd | bd | bd |
| | 18-Feb-04 | 13:07 to 14:07 | 0.3 | 0.003 | 4.3 | 0.9 | 5.2 | 3 | 0.011 | 0.016 | 0.027 | 0.026 | 2 | 2 | 1 | 0.003 | 0.003 | 0.001 |
| | 18-Feb-04 | 14:07 to 15:07 | 0.3 | 0.004 | 3.5 | 0.8 | 4.3 | 3 | 0.011 | 0.009 | 0.020 | 0.027 | 2 | 1 | 1 | 0.002 | 0.002 | bd |
| | 20-May-04 | 08:24 to 09:24 | 0.1 | 0.002 | 3.7 | 0.8 | 4.5 | 3 | 0.008 | 0.008 | 0.016 | 0.034 | 80 | 52 | 7 | 0.001 | 0.001 | 0.001 |
| | 20-May-04 | 09:24 to 10:24 | 0.1 | 0.001 | 3.8 | 0.7 | 4.5 | 6 | 0.010 | 0.011 | 0.021 | 0.034 | 120 | 71 | 8 | bd | bd | 0.001 |
| | 20-May-04 | 15:51 to 16:51 | 0.1 | bd | 2.5 | 0.4 | 2.9 | bd | 0.003 | 0.002 | 0.005 | 0.042 | 176 | 111 | 11 | bd | bd | 0.001 |
| | 4-Aug-04 | 12:34 to 13:34 | 0.1 | 0.001 | 2.6 | 1.3 | 3.9 | 5 | 0.006 | 0.009 | 0.015 | 0.023 | 123 | 77 | 9 | 0.001 | 0.001 | 0.003 |
| | 4-Aug-04 | 13:34 to 14:34 | 0.1 | 0.001 | 2.4 | 0.7 | 3.1 | 4 | 0.003 | 0.005 | 0.008 | 0.030 | 166 | 105 | 12 | bd | 0.001 | 0.003 |
| | 5-Aug-04 | 08:49 to 09:49 | 0.3 | 0.002 | 2.5 | 0.1 | 2.6 | 8 | 0.006 | 0.010 | 0.016 | 0.019 | 132 | 71 | 7 | 0.001 | 0.001 | 0.001 |
| | 24-Nov-04 | 14:17 to 15:17 | bd | 0.002 | 2.8 | 0.2 | 3.0 | 3 | 0.009 | 0.014 | 0.023 | 0.000 | 305 | 190 | 47 | bd | 0.002 | 0.002 |
| Site 4 Little Dipper Used Oil Recovery | 14-May-02 | 13:29 to 14:30 | bd | 0.002 | 1.8 | 0.3 | 2.1 | bd | bd | bd | bd | 0.033 | 115 | 67 | 8 | bd | bd | bd |
| | 15-May-02 | 09:05 to 09:05 | 0.1 | 0.001 | 1.9 | 0.2 | 2.1 | bd | 0.002 | 0.009 | 0.011 | 0.031 | 19 | 12 | 1 | bd | 0.001 | 0.001 |
| | 15-May-02 | 15:45 to 16:46 | 0.1 | 0.002 | 1.9 | 0.3 | 2.2 | bd | 0.005 | 0.006 | 0.011 | 0.038 | 71 | 46 | 5 | bd | bd | bd |
| | 16-May-02 | 08:04 to 09:05 | 0.2 | 0.003 | 2.1 | 0.2 | 2.3 | bd | 0.008 | 0.007 | 0.013 | ND | 365 | 220 | 18 | bd | bd | bd |
| | 30-Jul-02 | 13:51 to 14:51 | bd | 0.001 | 1.8 | 0.1 | 1.9 | bd | 0.003 | 0.004 | 0.007 | 0.034 | 10 | 6 | 1 | bd | bd | bd |
| | 7-Oct-02 | 16:02 to 17:02 | bd | 0.002 | 2.3 | 0.2 | 2.5 | bd | 0.006 | 0.011 | 0.017 | 0.026 | 3 | 2 | bd | bd | 0.001 | bd |
| | 19-Feb-04 | 12:15 to 13:15 | 0.1 | 0.008 | 1.9 | 0.3 | 2.2 | bd | 0.008 | 0.009 | 0.017 | 0.033 | 2 | 1 | bd | bd | bd | 0.001 |
| | 19-Feb-04 | 16:06 to 17:06 | 0.2 | 0.004 | 1.9 | 0.2 | 2.1 | bd | 0.008 | 0.005 | 0.013 | 0.034 | 1 | 1 | bd | bd | bd | 0.001 |
| | 19-May-04 | 12:31 to 13:31 | bd | 0.002 | 2.9 | bd | 2.9 | 4 | 0.004 | 0.008 | 0.012 | 0.040 | 102 | 62 | 6 | bd | bd | bd |
| | 19-May-04 | 16:07 to 17:07 | 0.2 | 0.004 | 2.9 | 0.1 | 3.0 | 7 | 0.004 | 0.004 | 0.008 | 0.041 | 408 | 212 | 15 | bd | bd | bd |
| | 5-Aug-04 | 15:35 to 16:35 | 0.2 | bd | 2.0 | bd | 2.0 | bd | 0.001 | bd | 0.001 | 0.037 | 43 | 27 | 4 | bd | bd | 0.001 |
| | 25-Nov-04 | 13:14 to 14:14 | bd | 0.002 | 1.8 | bd | 1.8 | bd | 0.007 | 0.003 | 0.010 | 0.027 | 22 | 14 | 2 | bd | bd | 0.001 |
| | 25-Nov-04 | 14:14 to 15:14 | bd | bd | 1.8 | bd | 1.8 | 0 | 0.002 | bd | 0.002 | 0.026 | 9 | 6 | 1 | bd | bd | 0.001 |

Continued ...

**Table A5:** **... continued from previous page**

| Site | Date | Time (MST) | CO ppm | $NH_3$ ppm | $CH_4$ ppm | NHC ppm | THC ppm | PAH ng/m³ | $NO_2$ ppm | NO ppm | $NO_x$ ppm | $O_3$ ppm | TSP µg/m³ | $PM_{10}$ µg/m³ | $PM_{2.5}$ µg/m³ | $H_2S$ ppm | TRS ppm | $SO_2$ ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 Husky Oil Refinery | 14-May-02 | 14:42 to 15:43 | bd | 0.001 | 2.0 | 0.2 | 2.2 | bd | bd | bd | bd | 0.034 | 67 | 46 | 6 | bd | bd | bd |
| | 14-May-02 | 16:06 to 17:07 | 0.3 | 0.006 | 2.1 | 0.2 | 2.3 | 21 | 0.009 | 0.016 | 0.025 | 0.023 | 142 | 98 | 13 | 0.003 | 0.003 | 0.002 |
| | 15-May-02 | 18:00 to 19:01 | bd | 0.004 | 2.0 | 0.2 | 2.2 | bd | 0.002 | 0.003 | 0.005 | 0.042 | 261 | 149 | 13 | bd | bd | 0.001 |
| | 16-May-02 | 12:18 to 13:19 | 0.2 | 0.003 | 1.6 | 0.4 | 2.0 | 6 | 0.012 | 0.008 | 0.020 | 0.042 | 425 | 282 | 33 | bd | bd | bd |
| | 29-Jul-02 | 13:12 to 14:12 | 0.3 | bd | 2.1 | 0.2 | 2.3 | bd | 0.005 | 0.007 | 0.013 | 0.034 | 4 | 2 | 1 | 0.015 | 0.017 | 0.010 |
| | 29-Jul-02 | 14:12 to 15:12 | 0.2 | bd | 2.1 | 0.2 | 2.3 | bd | 0.005 | 0.005 | 0.012 | 0.034 | 6 | 3 | 1 | 0.006 | 0.008 | 0.004 |
| | 30-Jul-02 | 11:31 to 12:31 | 0.1 | bd | 1.8 | bd | 1.8 | bd | 0.004 | 0.005 | 0.009 | 0.036 | 9 | 6 | 1 | 0.020 | 0.022 | 0.002 |
| | 30-Jul-02 | 12:31 to 13:31 | bd | bd | 1.8 | bd | 1.8 | bd | 0.003 | 0.003 | 0.006 | 0.036 | 8 | 5 | 1 | 0.005 | 0.006 | bd |
| | 30-Jul-02 | 16:08 to 16:08 | bd | bd | 1.9 | bd | 1.9 | bd | 0.001 | bd | 0.001 | 0.035 | 5 | 3 | bd | bd | bd | bd |
| | 30-Jul-02 | 17:35 to 18:35 | 0.1 | 0.001 | 2.0 | 0.3 | 2.3 | 6 | 0.006 | 0.011 | 0.017 | 0.034 | 19 | 13 | 4 | 0.017 | 0.017 | 0.001 |
| | 31-Jul-02 | 07:49 to 08:49 | 0.2 | bd | 1.8 | bd | 1.8 | bd | 0.002 | 0.004 | 0.006 | 0.011 | 17 | 11 | 1 | 0.002 | 0.002 | bd |
| | 31-Jul-02 | 10:50 to 11:50 | 0.1 | bd | 1.8 | 0.1 | 1.9 | 6 | 0.002 | 0.005 | 0.007 | 0.033 | 25 | 16 | 2 | 0.003 | 0.003 | bd |
| | 7-Oct-02 | 13:39 to 14:39 | 0.2 | 0.001 | 2.6 | 0.2 | 2.8 | bd | 0.005 | 0.009 | 0.014 | 0.027 | 6 | 4 | 1 | 0.001 | 0.003 | 0.002 |
| | 7-Oct-02 | 14:46 to 15:46 | 0.1 | bd | 2.5 | 0.1 | 2.6 | 3 | 0.003 | 0.003 | 0.006 | 0.030 | 6 | 4 | 1 | 0.004 | 0.004 | bd |
| | 8-Oct-02 | 15:19 to 16:19 | 0.2 | bd | 2.0 | bd | 2.0 | bd | 0.003 | 0.001 | 0.004 | 0.034 | 7 | 5 | 1 | bd | 0.001 | bd |
| | 9-Oct-02 | 10:06 to 11:06 | 0.3 | 0.005 | 2.1 | 0.1 | 2.2 | 6 | 0.007 | 0.005 | 0.012 | 0.034 | 21 | 14 | 2 | 0.001 | 0.001 | 0.001 |
| | 26-Feb-03 | 14:50 to 15:50 | 0.6 | 0.003 | 3.9 | bd | 3.9 | ND | 0.014 | 0.012 | 0.026 | 0.036 | 3 | 2 | 1 | 0.009 | 0.010 | 0.003 |
| | 27-Feb-03 | 09:01 to 10:01 | 0.7 | 0.001 | 3.2 | bd | 3.2 | bd | 0.009 | 0.006 | 0.015 | 0.031 | 3 | 2 | 1 | 0.005 | 0.006 | 0.004 |
| | 27-Feb-03 | 10:38 to 11:38 | 0.6 | 0.001 | 3.2 | bd | 3.2 | 3 | 0.008 | 0.008 | 0.016 | 0.031 | 3 | 3 | 2 | 0.004 | 0.006 | 0.005 |
| | 27-Feb-03 | 15:44 to 16:44 | 0.6 | bd | 2.6 | 0.2 | 2.8 | bd | 0.010 | 0.003 | 0.013 | 0.029 | 2 | 1 | 1 | 0.001 | 0.003 | 0.004 |
| | 27-Feb-03 | 16:59 to 17:59 | 0.7 | 0.003 | 2.7 | 0.2 | 2.9 | 3 | 0.016 | 0.006 | 0.022 | 0.024 | 1 | 1 | bd | 0.001 | 0.001 | 0.002 |
| | 28-Feb-03 | 09:15 to 10:15 | 0.4 | 0.001 | 3.4 | bd | 3.4 | bd | 0.010 | 0.014 | 0.024 | 0.030 | 3 | 2 | 1 | 0.001 | 0.003 | 0.003 |
| | 18-Feb-04 | 17:43 to 17:43 | 0.4 | 0.001 | 2.8 | bd | 2.8 | 3 | 0.017 | 0.006 | 0.023 | 0.021 | 4 | 2 | 1 | 0.002 | 0.003 | bd |
| | 18-Feb-04 | 18:01 to 19:01 | 0.3 | bd | 2.9 | bd | 2.9 | 6 | 0.024 | 0.005 | 0.029 | 0.011 | 2 | 1 | 1 | 0.001 | 0.001 | bd |
| | 19-Feb-04 | 08:44 to 09:44 | 0.1 | 0.004 | 2.3 | bd | 2.3 | bd | 0.013 | 0.009 | 0.021 | 0.024 | 4 | 3 | 2 | 0.008 | 0.008 | 0.001 |
| | 19-Feb-04 | 17:23 to 18:23 | 0.2 | 0.004 | 2.0 | 0.3 | 2.3 | bd | 0.011 | 0.012 | 0.023 | 0.030 | 3 | 3 | 2 | 0.011 | 0.013 | 0.001 |
| | 19-Feb-04 | 18:23 to 19:23 | 0.2 | 0.004 | 2.1 | 0.2 | 2.3 | bd | 0.010 | 0.003 | 0.013 | 0.036 | 3 | 2 | 2 | 0.012 | 0.012 | bd |
| | 20-Feb-04 | 08:42 to 09:42 | 0.2 | bd | 2.6 | bd | 2.6 | 3 | 0.012 | 0.009 | 0.021 | 0.020 | 4 | 3 | 1 | 0.006 | 0.006 | 0.002 |
| | 19-May-04 | 13:48 to 14:48 | 0.2 | 0.004 | 3.0 | bd | 3.0 | 6 | 0.010 | 0.016 | 0.026 | 0.037 | 143 | 82 | 9 | bd | bd | 0.001 |
| | 20-May-04 | 12:15 to 13:15 | bd | bd | 2.3 | 0.2 | 2.5 | bd | 0.003 | 0.004 | 0.007 | 0.043 | 47 | 29 | 3 | bd | bd | bd |
| | 20-May-04 | 13:15 to 14:15 | bd | bd | 2.3 | 0.1 | 2.4 | bd | 0.002 | 0.002 | 0.004 | 0.043 | 88 | 52 | 6 | bd | bd | bd |
| | 21-May-04 | 08:10 to 09:10 | 0.1 | 0.001 | 3.3 | 0.2 | 3.5 | bd | 0.004 | 0.006 | 0.009 | 0.036 | 73 | 47 | 6 | 0.004 | 0.006 | 0.002 |
| | 4-Aug-04 | 16:11 to 17:11 | 0.3 | bd | 2.2 | bd | 2.2 | 6 | 0.003 | 0.002 | 0.006 | 0.029 | 66 | 47 | 7 | 0.002 | 0.003 | 0.002 |
| | 5-Aug-04 | 11:43 to 12:43 | 0.2 | 0.001 | 2.3 | bd | 2.3 | bd | 0.003 | 0.003 | 0.006 | 0.035 | 41 | 23 | 3 | bd | 0.001 | 0.001 |
| | 5-Aug-04 | 12:58 to 13:58 | 0.1 | bd | 2.2 | bd | 2.2 | bd | 0.001 | 0.003 | 0.004 | 0.036 | 21 | 14 | 2 | 0.001 | 0.003 | 0.001 |
| | 6-Aug-04 | 10:04 to 11:04 | 0.1 | bd | 2.1 | bd | 2.1 | bd | 0.003 | 0.004 | 0.007 | 0.034 | 16 | 11 | 3 | 0.011 | 0.016 | 0.002 |
| | 24-Nov-04 | 15:35 to 16:35 | 0.1 | bd | 2.6 | bd | 2.6 | 4 | 0.000 | bd | 0.000 | 0.017 | 41 | 27 | 3 | bd | bd | 0.001 |
| | 24-Nov-04 | 16:56 to 17:56 | 0.1 | 0.003 | 2.6 | bd | 2.6 | 12 | 0.011 | 0.007 | 0.018 | 0.010 | 78 | 55 | 9 | 0.003 | 0.003 | bd |
| | 24-Nov-04 | 17:56 to 18:56 | bd | 0.003 | 2.4 | bd | 2.4 | 7 | 0.006 | 0.002 | 0.007 | 0.014 | 27 | 19 | 3 | bd | bd | bd |
| | 25-Nov-04 | 08:49 to 09:49 | 0.1 | bd | 2.2 | bd | 2.2 | 3 | 0.008 | 0.007 | 0.015 | 0.015 | 15 | 10 | 3 | 0.009 | 0.009 | 0.003 |
| | 25-Nov-04 | 16:45 to 17:45 | 0.4 | bd | 2.2 | 0.2 | 2.4 | 17 | 0.024 | 0.020 | 0.044 | 0.006 | 151 | 96 | 10 | bd | bd | 0.001 |
| | 25-Nov-04 | 17:49 to 18:49 | 0.2 | bd | 2.2 | 0.1 | 2.3 | 8 | 0.017 | 0.004 | 0.021 | 0.012 | 45 | 33 | 7 | 0.003 | 0.003 | 0.001 |

**NOTES:**
ND – not determined (analyzer not functioning)
bd – below detection limit of analyzer

Intentionally Blank

**Table A6** **Volatile Organic Compounds in ug/m³ (Canister Analysis Results)**

| Target Source Facility | Greif | none (Upwind) | Greif | Greif | Husky Refinery & Greif | Husky Refinery & Greif | Husky Refinery | Husky Refinery & Greif | Husky Refinery | Objectives, Limits and Screening Levels | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Description / Comments | Sampled 30 meters west of Greif Containers | Sampled 20 meters east of Greif Containers | Southeast corner of Greif property, 165 meters from Greif stack | Southeast corner of Greif property, 165 meters from Greif stack | East side of Greif Property, detect odours from both Husky and Greif | East side of Greif Property, detect odours from both Husky and Greif | Entrance to Lloydminster Estates, 448m from Husky flare stack. | East side of Greif property, 150 meters from Greif stack. Husky Refinery also upwind. | Upwind side of Greif building. Detect odours from Husky Refinery. | Alberta one-hour Objective[a] | Ontario half-hour POI[b] | Odour Threshold Range[c,d] | | 2003 Texas Effects Screening Level[e] |
| | | | | | | | | | | | | Low | High | |
| Sample Date | 15-May-02 | 15-May-02 | 26-Feb-03 | 26-Feb-03 | 27-Feb-03 | 27-Feb-03 | 9-Oct-02 | 19-Feb-04 | 19-Feb-04 | | | | | |
| Sample Duration | 1 hour | 1 hour | 1 hour | 1 minute | 1 minute | 1 hour | 1 minute | 1 hour | 1 hour | | | | | |
| Sample Start Time | 13:16 | 14:30 | 13:40 | 13:40 | 11:53 | 11:53 | 10:24 | 10:45 | 10:45 | | | | | |
| Canister Number | 1934 | 1933 | 5553 | 2219 | 6102 | 5354 | 1934 | 1936 | 2155 | | | | | |
| 1,1,1-Trichloroethane | 0.25 | 0.30 | 0.19 | 0.19 | 0.19 | 0.19 | 0.21 | 0.15 | 0.16 | | 350000 | 122135 | | |
| 1,1,2,2-Tetrachloroethane | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | 21000 | 35000 | 70 |
| 1,1,2-Trichloroethane | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| 1,1-Dichloroethane | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 600 | 891536 | | 4000 |
| 1,1-Dichloroethene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.00 | 0.00 | 0.00 | | 30 | | | |
| 1,2,3-Trimethylbenzene | 0.02 | 0.01 | 0.07 | 0.18 | 0.87 | 0.48 | 0.03 | 0.57 | 0.09 | | | | | |
| 1,2,4-Trichlorobenzene | 0.02 | 0.02 | 0.05 | 0.04 | 0.03 | 0.02 | 0.00 | 0.01 | 0.01 | | 100 | 24000 | | |
| 1,2,4-Trimethylbenzene | 0.09 | 0.03 | 0.19 | 0.40 | 2.05 | 1.04 | 0.08 | 2.34 | 0.30 | | 500 | | | |
| 1,2-Dibromoethane ( EDB ) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 9 | 76800 | | 4 |
| 1,2-Dichlorobenzene | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | | 37000 | 12000 | 300000 | |
| 1,2-Dichloroethane | 0.04 | 0.04 | 0.04 | 0.04 | 0.06 | 0.06 | 0.05 | 0.10 | 0.10 | | 6 | 24000 | 44000 | 16 |
| 1,2-Dichloropropane | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | | 2400 | 1167 | 606666 | 1150 |
| 1,2-Diethylbenzene | 0.00 | 0.00 | 0.01 | 0.02 | 0.09 | 0.06 | 0.00 | 0.05 | 0.01 | | | | | |
| 1,3,5-Trimethylbenzene | 0.03 | 0.01 | 0.04 | 0.09 | 0.66 | 0.31 | 0.03 | 0.74 | 0.09 | | | | | 1250 |
| 1,3-Butadiene | 0.02 | 0.01 | 0.04 | 0.03 | 0.05 | 0.06 | 0.05 | 0.06 | 0.04 | | | 352 | 2860 | 110 |
| 1,3-Dichlorobenzene | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | | | | | |
| 1,3-Diethylbenzene | 0.00 | 0.00 | 0.02 | 0.04 | 0.26 | 0.19 | 0.00 | 0.10 | 0.02 | | | | | |
| 1,4-Dichlorobenzene | 0.03 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.00 | 0.02 | 0.01 | | 285 | 288 | | |
| 1,4-Dichlorobutane | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| 1,4-Diethylbenzene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.07 | | | | | |
| 1-Butanol (Butyl alcohol) | 0.16 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 1.51 | 7.08 | 0.00 | | | | | |
| 1-Butene/2-Methylpropene | | | 0.15 | 0.10 | 0.22 | 0.24 | 0.17 | 0.26 | 0.24 | | | | | 160 |
| 1-Butyne | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | | | | | |
| 1-Decene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 180000 | | | |
| 1-Heptene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| 1-Hexene/2-Methyl-1-Pentene | 0.00 | 0.00 | 0.05 | 0.00 | 0.09 | 0.08 | 0.04 | 0.13 | 0.06 | | | | | |
| 1-Methylcyclohexene | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.06 | 0.02 | 0.01 | | | | | |
| 1-Methylcyclopentene | 0.00 | 0.00 | 0.01 | 0.01 | 0.04 | 0.03 | 0.01 | 0.02 | 0.02 | | | | | |
| 1-Nonene | 0.00 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| 1-Octene | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | | 150000 | | | |
| 1-Pentene | 0.09 | 0.03 | 0.06 | 0.03 | 0.09 | 0.09 | 0.11 | 0.00 | 0.06 | | | | | |
| 1-Undecene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |

Continued ...

**Table A6** **... continued from previous page**

| Target Source Facility | Greif | none (Upwind) | Greif | Greif | Husky Refinery & Greif | Husky Refinery & Greif | Husky Refinery | Husky Refinery & Greif | Husky Refinery | Objectives, Limits and Screening Levels | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Description / Comments | Sampled 30 meters west of Greif Containers | Sampled 20 meters east of Greif Containers | Southeast corner of Greif property, 165 meters from Greif stack | Southeast corner of Greif property, 165 meters from Greif stack | East side of Greif Property, detect odours from both Husky and Greif | East side of Greif Property, detect odours from both Husky and Greif | Entrance to Lloydminster Estates, 448m from Husky flare stack. | East side of Greif property, 150 meters from Greif stack. Husky Refinery also upwind. | Upwind side of Greif building. Detect odours from Husky Refinery | Alberta one-hour Objective[a] | Ontario half-hour POI[b] | Odour Threshold Range[c,d] | | 2003 Texas Effects Screening Level[e] |
| Sample Date | 15-May-02 | 15-May-02 | 26-Feb-03 | 26-Feb-03 | 27-Feb-03 | 27-Feb-03 | 9-Oct-02 | 19-Feb-04 | 19-Feb-04 | | | | | |
| Sample Duration | 1 hour | 1 hour | 1 hour | 1 minute | 1 minute | 1 hour | 1 minute | 1 hour | 1 hour | | | | | |
| Sample Start Time | 13:16 | 14:30 | 13:40 | 13:40 | 11:53 | 11:53 | 10:24 | 10:45 | 10:45 | | | | | |
| Canister Number | 1934 | 1933 | 5553 | 2219 | 6102 | 5354 | 1934 | 1936 | 2155 | | | Low | High | |
| 2,2,3-Trimethylbutane | 0.00 | 0.00 | 0.02 | 0.02 | 0.05 | 0.04 | 0.03 | 0.02 | 0.01 | | | | | |
| 2,2,4-Trimethylpentane | 0.04 | 0.05 | 0.17 | 0.00 | 0.00 | 0.00 | 0.19 | 0.00 | 0.14 | | | | | |
| 2,2,5-Trimethylhexane | 0.00 | 0.00 | 0.02 | 0.01 | 0.07 | 0.02 | 0.02 | 0.03 | 0.00 | | | | | |
| 2,2-Dimethylbutane | 0.01 | 0.02 | 0.12 | 0.09 | 0.41 | 0.33 | 0.13 | 0.15 | 0.11 | | | | | |
| 2,2-Dimethylhexane | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| 2,2-Dimethylpentane | 0.00 | 0.00 | 0.04 | 0.03 | 0.13 | 0.13 | 0.06 | 0.04 | 0.04 | | | | | |
| 2,2-Dimethylpropane | 0.01 | 0.02 | 0.09 | 0.06 | 0.22 | 0.19 | 0.09 | 0.08 | 0.05 | | | | | |
| 2,3,4-Trimethylpentane | 0.02 | 0.02 | 0.06 | 0.03 | 0.10 | 0.07 | 0.13 | 0.06 | 0.05 | | | | | |
| 2,3-Dimethylbutane | 0.00 | 0.04 | 0.23 | 0.16 | 0.75 | 0.71 | 0.29 | 0.29 | 0.25 | | | | | |
| 2,3-Dimethylpentane | 0.06 | 0.07 | 0.32 | 0.21 | 0.61 | 0.57 | 0.68 | 0.34 | 0.28 | | | | | |
| 2,4-Dimethylhexane | 0.00 | 0.01 | 0.07 | 0.05 | 0.40 | 0.15 | 0.34 | 0.13 | 0.06 | | | | | |
| 2,4-Dimethylpentane | 0.02 | 0.03 | 0.12 | 0.08 | 0.00 | 0.00 | 0.17 | 0.15 | 0.12 | | | | | |
| 2,5-Dimethylhexane | 0.00 | 0.01 | 0.05 | 0.03 | 0.30 | 0.12 | 0.30 | 0.08 | 0.05 | | | | | |
| 2-Butanone (MEK) | | | 8.15 | 7.69 | 58.86 | 24.44 | 0.60 | | | | | 7 | 251 | 3900 |
| 2-Butanol | | | | | | | | 0.00 | 0.00 | | | | | |
| 2-Butenal (Crotonaldehdye) | | | | | | | | 0.00 | 0.00 | | | | | |
| 2-Ethyl-1-Butene | 0.06 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| 2-Ethyltoluene | 0.03 | 0.01 | 0.07 | 0.10 | 0.50 | 0.25 | 0.03 | 0.49 | 0.08 | | | | | |
| 2-Methyl-1-Butene | 0.02 | 0.03 | 0.06 | 0.00 | 0.06 | 0.06 | 0.06 | 0.10 | 0.08 | | | | | |
| 2-Methyl-2-Butene | 0.03 | 0.02 | 0.06 | 0.03 | 0.09 | 0.08 | 0.04 | 0.13 | 0.10 | | | | | |
| 2-Methylbutanal(Isovaleraldehyde) | | | | | | | | 0.00 | 0.00 | | | | | |
| 2-Methylbutane | 0.28 | 0.40 | 1.89 | 1.74 | 12.93 | 10.45 | 9.77 | 5.37 | 4.37 | | | | | |
| 2-Methylfuran | | | | | | | | 0.00 | 0.00 | | | | | |
| 2-Methylheptane | 0.06 | 0.01 | 0.28 | 0.23 | 3.55 | 0.78 | 1.31 | 1.27 | 0.25 | | | | | |
| 2-Methylhexane | 0.03 | 0.04 | 0.20 | 0.17 | 0.95 | 0.77 | 1.87 | 0.45 | 0.45 | | | | | |
| 2-Methylpentane | 0.09 | 0.08 | 0.69 | 0.66 | 4.18 | 4.35 | 1.40 | 1.22 | 1.10 | | | | | |
| 2-Pentanone | | | | | | | 0.00 | 0.36 | 0.36 | | | | | |
| 3,6-Dimethyloctane | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| 3-Ethyltoluene | 0.06 | 0.02 | 0.15 | 0.23 | 1.34 | 0.64 | 0.06 | 1.34 | 0.13 | | | | | |
| 3-Methyl-1-Butene | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | | | | | |
| 3-Methyl-1-Pentene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | | | | | |
| 3-Methylheptane | 0.10 | 0.02 | 0.24 | 0.17 | 3.06 | 0.66 | 0.62 | 1.09 | 0.15 | | | | | |

Continued ...

**Table A6** **... continued from previous page**

| Target Source Facility | Greif | none (Upwind) | Greif | Greif | Husky Refinery & Greif | Husky Refinery & Greif | Husky Refinery | Husky Refinery & Greif | Husky Refinery | Objectives, Limits and Screening Levels | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Description / Comments | Sampled 30 meters west of Greif Containers | Sampled 20 meters east of Greif Containers | Southeast corner of Greif property, 165 meters from Greif stack | Southeast corner of Greif property, 165 meters from Greif stack | East side of Greif Property, detect odours from both Husky and Greif | East side of Greif Property, detect odours from both Husky and Greif | Entrance to Lloydminster Estates, 448m from Husky flare stack. | East side of Greif property, 150 meters from Greif stack. Husky Refinery also upwind. | Upwind side of Greif building. Detect odours from Husky Refinery. | Alberta one-hour Objective[2] | Ontario half-hour POI[3] | Odour Threshold Range[5,6] | | 2003 Texas Effects Screening Level[4] |
| Sample Date | 15-May-02 | 15-May-02 | 26-Feb-03 | 26-Feb-03 | 27-Feb-03 | 27-Feb-03 | 9-Oct-02 | 19-Feb-04 | 19-Feb-04 | | | | | |
| Sample Duration | 1 hour | 1 hour | 1 hour | 1 minute | 1 minute | 1 hour | 1 minute | 1 hour | 1 hour | | | | | |
| Sample Start Time | 13:16 | 14:30 | 13:40 | 13:40 | 11:53 | 11:53 | 10:24 | 10:45 | 10:45 | | | | | |
| Canister Number | 1934 | 1933 | 5553 | 2219 | 6102 | 5354 | 1934 | 1936 | 2155 | | | Low | High | |
| 3-Methylhexane | 0.03 | 0.04 | 0.24 | 0.20 | 0.96 | 0.79 | 1.65 | 0.46 | 0.45 | | | | | |
| 3-Methylpentane | 0.31 | 0.08 | 0.43 | 0.41 | 2.68 | 3.77 | 1.03 | 0.00 | 0.78 | | | | | |
| 4-Ethyltoluene | 0.03 | 0.01 | 0.08 | 0.10 | 0.62 | 0.30 | 0.02 | 0.67 | 0.07 | | | | | |
| 4-Methyl-1-Pentene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.04 | | | | | |
| 4-Methylheptane | 0.02 | 0.00 | 0.10 | 0.07 | 1.08 | 0.24 | 0.31 | 0.44 | 0.08 | | | | | |
| Acetaldehyde | | | 4.51 | 2.85 | 3.48 | 3.97 | 1.95 | 4.00 | 4.96 | 90 | | 0.2 | 4140 | 90 |
| Acetone | | | 7.04 | 4.45 | 9.69 | 7.51 | 2.06 | 38.68 | 8.44 | 5900 | 48000 | 474667 | 1613860 | 5900 |
| Acetonitrile | | | | | | | 0.02 | 0.12 | 0.00 | | | | | 340 |
| Acrolein (2-Propenal) | | | 1.82 | 0.97 | 0.00 | 1.42 | 0.00 | 0.48 | 0.56 | | | | | 2.3 |
| Acrylonitrile (2-Propennitrile) | | | | | | | | 0.00 | 0.00 | 43 | | | | 40 |
| a-Pinene | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | 60 |
| Benzaldehyde | | | 0.38 | 0.47 | 0.00 | 0.37 | | 0.72 | 0.20 | | | | | |
| Benzene | 0.20 | 0.22 | 0.66 | 0.62 | 1.51 | 1.40 | 1.02 | 1.13 | 1.08 | 30 | | 4500 | 270000 | 75 |
| Benzyl Chloride | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | 235 | 1550 | 50 |
| b-Pinene | 0.03 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| Bromodichloromethane | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.23 | 0.00 | 0.00 | | | | | |
| Bromoform | 0.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.00 | 0.02 | 0.02 | | 165 | 5300000 | | 50 |
| Bromomethane | 0.06 | 0.06 | 0.08 | 0.08 | 0.08 | 0.08 | 0.09 | 0.06 | 0.06 | | 4000 | | | |
| Bromotrichloromethane | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| Butane | 0.35 | 0.43 | 2.20 | 1.93 | 7.20 | 6.44 | 3.06 | 7.99 | 7.74 | | | 2850 | 484610 | 19000 |
| Butylacetate | | | 0.00 | 0.00 | 0.93 | 0.21 | 0.16 | 1.12 | 0.00 | | 315 | | | 1850 |
| Butylaldehyde (Butanal) | | | | | | | | 0.00 | 0.72 | | | | | |
| c-1,2-Dichloroethene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| c-1,2-Dimethylcyclohexane | 0.06 | 0.00 | 0.08 | 0.06 | 1.04 | 0.20 | 0.07 | 0.40 | 0.03 | | | | | |
| c-1,3-Dichloropropene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| c-1,3-Dimethylcyclohexane | 0.14 | 0.02 | 0.36 | 0.22 | 5.62 | 1.01 | 1.19 | 2.16 | 0.17 | | | | | |
| c-1,4/t-1,3-Dimethylcyclohexane | 0.05 | 0.00 | 0.13 | 0.09 | 2.03 | 0.34 | 0.13 | 0.75 | 0.04 | | | | | |
| c-2-Butene | 0.02 | 0.01 | 0.02 | 0.00 | 0.03 | 0.03 | 0.02 | 0.04 | 0.05 | | | | | |
| c-2-Heptene | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.06 | 0.08 | 0.00 | 0.00 | | | | | |
| c-2-Hexene | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.00 | 0.00 | 0.00 | | | | | |
| c-2-Pentene | 0.01 | 0.01 | 0.02 | 0.00 | 0.04 | 0.03 | 0.02 | 0.06 | 0.05 | | | | | |
| c-3-Heptene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |

Continued ...

**Table A6** **... continued from previous page**

| Target Source Facility | Greif | none (Upwind) | Greif | Greif | Husky Refinery & Greif | Husky Refinery & Greif | Husky Refinery | Husky Refinery & Greif | Husky Refinery | Objectives, Limits and Screening Levels | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Description / Comments | Sampled 30 meters west of Greif Containers | Sampled 20 meters east of Greif Containers | Southeast corner of Greif property, 165 meters from Greif stack | Southeast corner of Greif property, 165 meters from Greif stack | East side of Greif Property, detect odours from both Husky and Greif | East side of Greif Property, detect odours from both Husky and Greif | Entrance to Lloydminster Estates, 448m from Husky flare stack. | East side of Greif property, 150 meters from Greif stack. Husky Refinery also upwind. | Upwind side of Greif building. Detect odours from Husky Refinery. | Alberta one-hour Objective[a] | Ontario half-hour POI[b] | Odour Threshold Range[c,d] | | 2003 Texas Effects Screening Level[e] |
| Sample Date | 15-May-02 | 15-May-02 | 26-Feb-03 | 26-Feb-03 | 27-Feb-03 | 27-Feb-03 | 9-Oct-02 | 19-Feb-04 | 19-Feb-04 | | | | | |
| Sample Duration | 1 hour | 1 hour | 1 hour | 1 minute | 1 minute | 1 hour | 1 minute | 1 hour | 1 hour | | | | | |
| Sample Start Time | 13:16 | 14:30 | 13:40 | 13:40 | 11:53 | 11:53 | 10:24 | 10:45 | 10:45 | | | | | |
| Canister Number | 1934 | 1933 | 5553 | 2219 | 6102 | 5354 | 1934 | 1936 | 2155 | | | Low | High | |
| c-3-Methyl-2-Pentene | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.02 | 0.00 | 0.00 | 0.02 | | | | | |
| c-4-Methyl-2-Pentene | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.00 | 0.02 | 0.03 | | | | | |
| Camphene | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | | | | | 50 |
| Carbon Disulfide | | | | | | | | 0.08 | 0.08 | 30 | | | | 30 |
| Carbontretrachloride | 0.66 | 0.70 | 0.64 | 0.64 | 0.65 | 0.67 | 0.70 | 0.66 | 0.69 | | 7.2 | 60000 | 128400 | 130 |
| Chlorobenzene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 4200 | 980 | 280000 | 460 |
| Chloroethane | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | | | | | 50 |
| Chloroform | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.07 | 0.07 | | 300 | 250000 | 1000000 | 100 |
| Chloromethane | 1.13 | 1.21 | 1.60 | 1.56 | 1.49 | 1.55 | 1.19 | 1.36 | 1.47 | | 20000 | | | |
| Cyclohexane | 0.00 | 0.02 | 0.28 | 0.25 | 1.57 | 0.00 | 1.37 | 0.00 | 0.43 | | 300000 | 1435 | | 1400 |
| Cyclohexanone | | | | | | | | 0.00 | 0.00 | | | | | 480 |
| Cyclohexene | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | 600 |
| Cyclopentane | 0.00 | 0.00 | 0.16 | 0.15 | 0.91 | 0.73 | 0.36 | 0.33 | 0.29 | | | | | 3400 |
| Cyclopentanone | | | 0.01 | 0.01 | 0.04 | 0.03 | | 0.00 | 0.00 | | | | | 1700 |
| Cyclopentene | 0.01 | 0.00 | | | | | 0.01 | 0.02 | 0.02 | | | | | 8100 |
| Decane | 0.17 | 0.05 | 0.78 | 1.28 | 5.24 | 2.00 | 0.09 | 4.51 | 0.60 | | | | | 10000 |
| Dibromochloromethane | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| Dibromomethane | 0.00 | 0.00 | 0.06 | 0.05 | 0.06 | 0.05 | 0.08 | 0.04 | 0.05 | | | | | |
| Dichloromethane | 0.21 | 0.20 | 0.19 | 0.20 | 0.20 | 0.20 | 0.51 | 0.27 | 0.23 | | 5300 | 540000 | 2160000 | |
| Dodecane | 0.05 | 0.03 | 0.06 | 0.12 | 0.27 | 0.20 | 0.04 | 0.18 | 0.16 | | | | | |
| Ethanol | | | 1.27 | 1.25 | 1.76 | 2.25 | 1.62 | 3.60 | 2.64 | | 19000 | 342 | 9690000 | 18800 |
| Ethylacetate | | | | | | | | 0.40 | 0.04 | | | | | 14400 |
| Ethylbenzene | 4.99 | 0.05 | 10.34 | 10.43 | 88.65 | 32.64 | 0.17 | 77.92 | 0.50 | 2000 | 3000 | 8700 | 870000 | 2000 |
| Ethylbromide | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | 890000 | | |
| Ethylene oxide | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.32 | 15 | 15 | 520000 | 1400000 | 20 |
| Freon 11 (Trichlorofluoromethane) | 1.76 | 1.90 | 1.74 | 1.78 | 1.77 | 1.82 | 2.05 | 1.82 | 1.94 | | 18000 | 28000 | 1170400 | 28000 |
| Freon 113 (1,1,2-Trichlorotrifluoroetha | 0.63 | 0.67 | 0.69 | 0.69 | 0.68 | 0.70 | 0.71 | 0.65 | 0.67 | | 2400000 | 342000 | 3729626 | 38000 |
| Freon 114 (1,2-Dichlorotetrafluoroethan | 0.13 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.15 | 0.14 | 0.15 | | 2100000 | | | 70000 |
| Freon 12 (Dichlorodifluoromethane) | 2.57 | 2.78 | 2.90 | 2.95 | 2.90 | 3.00 | 3.05 | 3.73 | 3.97 | | 1500000 | | | 28000 |
| Freon 22 (Chlorodifluoromethane) | 0.54 | 0.52 | 0.59 | 0.60 | 0.60 | 0.60 | 0.61 | 0.59 | 0.64 | | 1050000 | | | 18000 |
| Heptane | 0.04 | 0.03 | 0.33 | 0.33 | 2.17 | 1.37 | 6.66 | 0.59 | 0.58 | | 33000 | 40013 | 1280000 | 3500 |
| Hexachlorobutadiene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | 12000 | | 2 |

Continued ...

**Table A6** **... continued from previous page**

| Target Source Facility | Greif | none (Upwind) | Greif | Greif | Husky Refinery & Greif | Husky Refinery & Greif | Husky Refinery | Husky Refinery & Greif | Husky Refinery | Objectives, Limits and Screening Levels | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Description / Comments | Sampled 30 meters west of Greif Containers | Sampled 20 meters east of Greif Containers | Southeast corner of Greif property, 165 meters from Greif stack | Southeast corner of Greif property, 165 meters from Greif stack | East side of Greif Property, detect odours from both Husky and Greif | East side of Greif Property, detect odours from both Husky and Greif | Entrance to Lloydminster Estates, 448m from Husky flare stack. | East side of Greif property, 150 meters from Greif stack. Husky Refinery also upwind. | Upwind side of Greif building. Detect odours from Husky Refinery. | Alberta one-hour Objective[2] | Ontario half-hour POI[3] | Odour Threshold Range[4,6] | | 2003 Texas Effects Screening Level[5] |
| | | | | | | | | | | | | Low | High | |
| **Sample Date** | 15-May-02 | 15-May-02 | 26-Feb-03 | 26-Feb-03 | 27-Feb-03 | 27-Feb-03 | 9-Oct-02 | 19-Feb-04 | 19-Feb-04 | | | | | |
| **Sample Duration** | 1 hour | 1 hour | 1 hour | 1 minute | 1 minute | 1 hour | 1 minute | 1 hour | 1 hour | | | | | |
| **Sample Start Time** | 13:16 | 14:30 | 13:40 | 13:40 | 11:53 | 11:53 | 10:24 | 10:45 | 10:45 | | | | | |
| **Canister Number** | 1934 | 1933 | 5553 | 2219 | 6102 | 5354 | 1934 | 1936 | 2155 | | | | | |
| **Hexanal** | 0.58 | 0.10 | | | | | | 1.48 | 0.00 | | | | | |
| Hexane | 0.01 | 0.01 | 0.67 | 0.89 | 5.23 | 8.01 | 2.41 | 1.99 | 1.86 | | 35000 | 77141 | | 1760 |
| **Hexylbenzene** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| Indan (2,3-Dihydroindene) | 0.13 | 0.16 | 0.02 | 0.03 | 0.19 | 0.14 | 0.01 | 0.10 | 0.02 | | | | | |
| **Isobutane (2-Methylpropane)** | | | 1.26 | 0.97 | 3.31 | 2.75 | 0.57 | 2.86 | 3.00 | | | | | 4800 |
| Isobutylacetate | | | | | | | | 0.40 | 0.04 | | | | | 630 |
| **Isobutylalcohol** | | | | | | | | 0.00 | 0.00 | | | | | 1520 |
| Isobutylaldehyde(2-Methylpropanl) | | | | | | | | 93.40 | 0.88 | | | | | 140 |
| **iso-Butylbenzene** | 0.00 | 0.00 | 0.01 | 0.02 | 0.09 | 0.04 | 0.00 | 0.06 | 0.01 | | | | | |
| Isoprene (2-Methyl-1,3-Butadiene) | 0.03 | 0.02 | 0.03 | 0.00 | 0.05 | 0.05 | 0.04 | 0.06 | 0.07 | | | | | 14 |
| **Isopropyl Alcohol** | | | 1.86 | 1.70 | 7.55 | 3.78 | 0.25 | 68.80 | 0.00 | 7850 | | | | 7850 |
| Isopropylacetate | | | | | | | 0.01 | 1.08 | 0.00 | | | | | 3760 |
| **iso-Propylbenzene** | 0.03 | 0.00 | 0.13 | 0.16 | 1.12 | 0.52 | | 0.74 | 0.03 | | 100 | | | 500 |
| Limonene | 0.01 | 0.01 | 0.00 | 0.00 | 0.05 | 0.13 | 0.00 | 0.03 | 0.03 | | | | | |
| **m,p-Xylene** | 20.00 | 0.12 | 34.67 | 34.76 | 277.20 | 108.12 | 0.47 | 253.36 | 1.59 | 2300 | 2300 | 348 | 174000 | 3700 |
| MAC (2-Methyl-2-propenal) | | | | | | | | 0.00 | 0.00 | | | | | |
| **Methanol** | | | 3.90 | 4.16 | 9.47 | 7.56 | 2.91 | 17.16 | 8.28 | 2600 | 12000 | | | 2620 |
| Methylcyclohexane | 0.06 | 0.04 | 0.54 | 0.46 | 4.56 | 1.92 | 12.29 | 1.15 | 0.75 | | | 2000000 | | 16100 |
| **Methylcyclopentane** | 0.16 | 0.05 | 0.39 | 0.34 | 1.95 | 2.18 | 0.87 | 0.75 | 0.76 | | | | | 2600 |
| Methyl-t-Butyl Ether ( MTBE ) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 2200 | | | 450 |
| **MIBK** | | | | | | | | 0.20 | 0.00 | | | | | 2050 |
| MVK | | | | | | | | 0.00 | 0.00 | | | | | 6 |
| **Naphthalene** | 0.08 | 0.03 | 0.03 | 0.06 | 0.92 | 1.00 | 0.05 | 0.10 | 0.07 | | 36 | 1500 | 125000 | 440 |
| n-Butylbenzene | 0.00 | 0.00 | 0.03 | 0.07 | 0.37 | 0.23 | 0.00 | 0.22 | 0.03 | | | | | 2740 |
| **Nonane** | 0.14 | 0.04 | 0.38 | 0.51 | 3.08 | 1.01 | 0.16 | 1.77 | 0.43 | | | 6605 | 3412500 | 10500 |
| n-Propylbenzene | 0.04 | 0.01 | 0.10 | 0.15 | 0.84 | 0.37 | 0.03 | 0.75 | 0.07 | | | | | |
| **Octane** | 0.22 | 0.03 | 0.42 | 0.37 | 5.78 | 1.26 | 0.75 | 2.45 | 0.36 | | 45400 | 26846 | 1208330 | 3500 |
| o-Xylene | 3.11 | 0.04 | 10.10 | 11.28 | 78.47 | 33.07 | 0.13 | 65.76 | 0.50 | | | 3693 | | 3700 |
| **p-Cymene (1-Methyl-4-Isopropylbenzene)** | 0.01 | 0.00 | 0.02 | 0.04 | 0.16 | 0.06 | 0.00 | 0.12 | 0.03 | | | | | 2750 |
| Pentanal | | | | | | | | 0.00 | 0.56 | | | | | |
| **Pentane** | 0.15 | 0.18 | 1.44 | 1.60 | 11.72 | 9.45 | 9.64 | 4.96 | 3.60 | | | 6600 | 3000000 | 3500 |
| Propane | 1.29 | 0.46 | 4.39 | 4.31 | 7.40 | 7.86 | 1.49 | 9.09 | 9.55 | | | 1800000 | 36000000 | 18000 |

Continued ...

**Table A6** **... continued from previous page**

| Target Source Facility | Greif | none (Upwind) | Greif | Greif | Husky Refinery & Greif | Husky Refinery & Greif | Husky Refinery | Husky Refinery & Greif | Husky Refinery | Objectives, Limits and Screening Levels | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Description / Comments | Sampled 30 meters west of Greif Containers | Sampled 20 meters east of Greif Containers | Southeast corner of Greif property, 165 meters from Greif stack | Southeast corner of Greif property, 165 meters from Greif stack | East side of Greif Property, detect odours from both Husky and Greif | East side of Greif Property, detect odours from both Husky and Greif | Entrance to Lloydminster Estates, 446m from Husky flare stack. | East side of Greif property, 150 meters from Greif stack. Husky Refinery also upwind. | Upwind side of Greif building. Detect odours from Husky Refinery. | Alberta one-hour Objective[a] | Ontario half-hour POI[b] | Odour Threshold Range[c,d] | | 2003 Texas Effects Screening Level[e] |
| | | | | | | | | | | | | Low | High | |
| Sample Date | 15-May-02 | 15-May-02 | 26-Feb-03 | 26-Feb-03 | 27-Feb-03 | 27-Feb-03 | 9-Oct-02 | 19-Feb-04 | 19-Feb-04 | | | | | |
| Sample Duration | 1 hour | 1 hour | 1 hour | 1 minute | 1 minute | 1 hour | 1 minute | 1 hour | 1 hour | | | | | |
| Sample Start Time | 13:16 | 14:30 | 13:40 | 13:40 | 11:53 | 11:53 | 10:24 | 10:45 | 10:45 | | | | | |
| Canister Number | 1934 | 1933 | 5553 | 2219 | 6102 | 5354 | 1934 | 1936 | 2155 | | | | | |
| Propene | 0.39 | 0.16 | 0.27 | 0.20 | 0.42 | 0.44 | 0.28 | 0.48 | 0.41 | | | | | |
| Propionaldehyde | | | | | | | | 2.04 | 1.96 | | | | | 20 |
| Propyl alcohol (1-Propanol) | | | | | | | | 0.00 | 0.00 | | | | | 4900 |
| Propyne | 0.02 | 0.02 | 0.04 | 0.04 | 0.05 | 0.06 | 0.05 | 0.06 | 0.04 | | | | | 16400 |
| sec-Butylbenzene | 0.00 | 0.00 | 0.03 | 0.05 | 0.19 | 0.08 | 0.01 | 0.13 | 0.02 | | | | | 2740 |
| Styrene | 0.02 | 0.01 | 0.01 | 0.01 | 0.07 | 0.08 | 0.01 | 0.24 | 0.02 | 215 | 400 | 202 | 860000 | 110 |
| t-1,2-Dichloroethene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| t-1,2-Dimethylcyclohexane | 0.10 | 0.00 | 0.29 | 0.22 | 3.84 | 0.76 | 0.79 | 1.73 | 0.18 | | | | | |
| t-1,3-Dichloropropene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| t-1,4-Dimethylcyclohexane | 0.06 | 0.01 | 0.18 | 0.13 | 2.35 | 0.47 | 0.68 | 1.06 | 0.12 | | | | | |
| t-2-Butene | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.07 | | | | | |
| t-2-Heptene | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.02 | 0.09 | 0.02 | 0.04 | | | | | |
| t-2-Hexene | 0.00 | 0.00 | 0.01 | 0.00 | 0.04 | 0.03 | 0.03 | 0.04 | 0.05 | | | | | |
| t-2-Octene | 0.00 | 0.00 | 0.10 | 0.02 | 0.00 | 0.00 | 0.00 | 0.13 | 0.00 | | | | | |
| t-2-Pentene | 0.03 | 0.02 | 0.04 | 0.02 | 0.08 | 0.06 | 0.03 | 0.15 | 0.10 | | | | | |
| t-3-Heptene | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.05 | 0.02 | 0.02 | | | | | |
| t-3-Methyl-2-Pentene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| t-4-Methyl-2-Pentene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| tert-Butylbenzene | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | |
| Tetrachloroethene | 0.06 | 0.04 | 0.05 | 0.08 | 0.14 | 0.10 | 0.10 | 0.17 | 0.18 | | 10000 | | | 3400 |
| Toluene | 68.54 | 0.31 | 23.72 | 22.16 | 136.68 | 43.48 | 7.71 | 240.12 | 1.83 | 1880 | 2000 | 8025 | 150000 | 1880 |
| Trichloroethene | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.00 | 0.03 | 0.04 | | 3500 | | | |
| Undecane | 0.11 | 0.04 | 0.44 | 0.78 | 2.67 | 1.28 | 0.07 | 2.65 | 0.38 | | | | | |
| Vinylchloride (Chloroethene) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 130 | 3 | 646 | | 130 |

**NOTES:**

a - Alberta Ambient Air Quality Objectives. Alberta Environment. April 2005.

b - Summary of Point of Impingement Standards, Point of Impingement Guidelines and Ambient Air Quality Criteria (AATCs). Standards Development Branch, Ontario Ministry of the Environment. September 2001.

c - Odor Thresholds and Irritation Levels of Several Chemical substances: A review. Jon Ruth. Am. Ind. Hyg. Assoc. J (47). 1986.

d - 3M 2001 Respirator Selection Guide. 3M. www.3m.com. 2001.

e - Texas Commission on Environmental Quality (TCEQ) Effects Screening Levels (ESLs). http://www.tceq.state.tx.us/. 2003

**Table A6** **Weather Conditions and MAML Operator Remarks (Greif Containers Site).**

| Site | Date | Time (MST) | Comments | Temperature | Relative Humidity | Wind Speed | Wind Direction |
|---|---|---|---|---|---|---|---|
| | | | | °C | % | km/h | degrees |
| Site 1 Greif Containers | 15-May-02 | 13:25 to 14:26 | North West side about 25m from facility. Downwind location. Set out canister # 1934. | 12.7 | 26.3 | 11.6 | 72 |
| | 15-May-02 | 14:28 to 15:29 | North East side of facility. Upwind location. Set out canister # 1933. | 14.7 | 21.2 | 10.9 | 97 |
| | 29-Jul-02 | 12:09 to 13:09 | Greif Containers | 19.1 | 38.8 | 15.3 | 271 |
| | 29-Jul-02 | 15:30 to 16:30 | Greif Containers | 20.8 | 24.7 | 19.4 | 293 |
| | 30-Jul-02 | 09:19 to 10:19 | Greif Containers | 18.1 | 34.3 | 12.3 | 267 |
| | 30-Jul-02 | 10:24 to 11:24 | Greif Containers | 17.4 | 32.8 | 16.3 | 263 |
| | 30-Jul-02 | 16:18 to 17:18 | Greif Containers | 22.2 | 25.7 | 15.5 | 284 |
| | 31-Jul-02 | 09:14 to 10:14 | Greif Containers | 10.8 | 66.1 | 21.6 | 289 |
| | 7-Oct-02 | 12:18 to 13:18 | 52 ave between 54A st and 55 st. Pick up odors | 9 | 86.2 | 24.3 | 309 |
| | 8-Oct-02 | 12:55 to 13:55 | 56A st and 52 ave. 145m to bldg and 185m from main exh scrubber. Pick up odors. | 14.5 | 48.6 | 18.1 | 227 |
| | 9-Oct-02 | 11:17 to 12:17 | 52 ave and 100m south of 56A st. Pick up odors. | 15.8 | 32.6 | 9.9 | 221 |
| | 26-Feb-03 | 13:40 to 14:40 | Light paint thinner odors. Set out canister # 5553 for 1 hr and canister # 2219 for a grab sample. Stack is 165m NW of MAML | -5.5 | 68.2 | 11.8 | 333 |
| | 27-Feb-03 | 12:39 to 13:39 | Downwind of both Greif and Husky Set out canister # 6102 (grab) and # 5354 (1 hr sample) at 1153 hrs. | -4.9 | 82.4 | 11.5 | 256 |
| | 19-Feb-04 | 09:53 to 10:45 | 52 Ave on the east side of Greif. Queen Elizabeth School is west across street from MAML | 2.3 | 61.1 | 12.8 | 265 |
| | 19-Feb-04 | 10:45 to 11:45 | Set out canisters # 1936 (source) and # 2155 (background) based on previous 22 min of RHC | 3.1 | 63.5 | 12.4 | 273 |
| | 19-Feb-04 | 14:45 to 15:45 | 52 Ave on the east side of Greif. Queen Elizabeth School is west across street from MAML | 4.5 | 67.3 | 12.1 | 275 |
| | 20-Feb-04 | 09:52 to 10:52 | Stop at 55 St 50m east of 52 Ave. Greif and Husky odours. | 2.7 | 63.4 | 12.7 | 272 |
| | 20-May-04 | 14:27 to 15:27 | Stop on 52 ave directly east of facility. This is upwind sample. Traffic road dust. | 13.7 | 40.2 | 9.9 | 86 |
| | 5-Aug-04 | 14:14 to 15:14 | Sample from north side of facility on property (30m from bldg). RHC from facility | 26.5 | 51.6 | 6 | 171 |
| | 6-Aug-04 | 08:53 to 09:53 | Sample at 52ave and 55st. East side and downwind of Greif. 40m to bldg | 20.2 | 71.2 | 7.3 | 292 |
| | 25-Nov-04 | 09:52 to 10:52 | Pick up light odours from Greif (paint odours). | 2.4 | 83.6 | 18.3 | 303 |
| | 25-Nov-04 | 10:52 to 11:52 | Pick up light odours from Greif (paint odours). | 2.3 | 83.5 | 16.2 | 294 |
| | 25-Nov-04 | 15:40 to 16:40 | Light odours from Greif Contatiners as well as Husky. H2S & PAH probably from Husky property. | -0.2 | 74.9 | 7.3 | 303 |
| | 26-Nov-04 | 10:19 to 11:19 | Pick up odours | -1.5 | 74.6 | 10.8 | 271 |

**Table A7 Weather Conditions and MAML Operator Remarks (AMD Agri-Industries Site).**

| Site | Date | Time (MST) | Comments | Temperature | Relative Humidity | Wind Speed | Wind Direction |
|---|---|---|---|---|---|---|---|
| | | | | °C | % | km/h | degrees |
| Site 2 ADM Agri-Industries | 14-May-02 | 17:13 to 18:14 | No elevated readings. No activity from plant | 17.5 | 24.4 | 18.6 | 158 |
| | 15-May-02 | 11:54 to 12:55 | 59 Ave & 52 St. PAH from local traffic. No odors or activty from plant | 12.9 | 28.2 | 9.4 | 75 |
| | 15-May-02 | 16:57 to 17:58 | 62 Ave & 42 St. Elevated particulate from traffic on plant site as well as local street traffic. | 16.4 | 16.5 | 5.8 | 127 |
| | 16-May-02 | 11:03 to 12:04 | Exhaust from local traffic | 17.8 | 17.5 | 7.9 | 182 |
| | 8-Oct-02 | 11:38 to 12:38 | 51 st and 59 ave. East side and 20m from property fence.Very light odors. | 12.1 | 62.7 | 12.8 | 196 |
| | 8-Oct-02 | 18:17 to 19:17 | 51 st and 59 ave. East side and 20m from property fence.Pick up odors. | 9.7 | 58.1 | 4.6 | 202 |
| | 9-Oct-02 | 08:30 to 09:30 | 51 st and 59 ave. East side and 20m from property fence.Very light odors. | 10.6 | 55.5 | 5.9 | 238 |
| | 26-Feb-03 | 16:51 to 17:51 | Pick up canola odors. Not strong but noticeable. | -7 | 72.4 | 3.5 | 264 |
| | 27-Feb-03 | 14:04 to 15:04 | Downwind of ADM. Stack exh is going over MAML but odors are still detected from facility | -4.2 | 80.4 | 7 | 304 |
| | 27-Feb-03 | 18:14 to 19:14 | Downwind of ADM. Strong odors from plant | -7.4 | 94.8 | 6.6 | 243 |
| | 28-Feb-03 | 10:41 to 11:41 | 600m straight east of ADM. Calm winds drifting from the NW | -8.6 | 72.9 | 4.2 | 263 |
| | 18-Feb-04 | 08:44 to 09:44 | 63 Ave 81m north of 52 St 480m from stack. Odours from plant | 0.1 | 79.4 | 8.6 | 120 |
| | 19-Feb-04 | 17:23 to 18:23 | Stop at 5808-50 St downwind 700m from plant stack. Pick up odours | 5.4 | 62.2 | 10.2 | 284 |
| | 20-Feb-04 | 08:42 to 09:42 | 80m south of 52 St on 63 Ave. Fountain Tire parking lot. Upwind of facility to confirm | 4.2 | 58.6 | 11.4 | 265 |
| | 20-Feb-04 | 18:23 to 19:23 | 5702-51 St downwind of facility and east 493m from hopper. Pick up odours and SO2 | 2.8 | 65.5 | 15.2 | 277 |
| | 19-May-04 | 13:15 to 14:15 | Stop on 47st between 59 and 62 ave. 135m from facility. | 20.3 | 21.7 | 14 | 151 |
| | 20-May-04 | 08:10 to 09:10 | W end of 48 st and west of 62 ave. Strong ADM odour. 335m from facility. Traffic road dust. | 11.2 | 51.6 | 13.5 | 93 |
| | 20-May-04 | 16:11 to 17:11 | Stop on 48st west of 62 ave. 225m west of facility. Strong odour from ADM. In and out of plume. | 13.5 | 26 | 10 | 90 |
| | 21-May-04 | 11:43 to 12:43 | Corner of 48st and 62ave. 179m west of ADM. In and out of ADM odours. Local traffic PAH & dust. | 14 | 23.1 | 9.1 | 103 |
| | 4-Aug-04 | 12:58 to 13:58 | Sample at 52 st and 63 ave. ADM intermittent odours. Particulate and PAH readings are from local truck traffic. | 22.9 | 54.8 | 27.8 | 158 |
| | 5-Aug-04 | 10:04 to 11:04 | Stop on southside of 52st 1/2 way between 62 & 63 ave. Intermittent odours. Some local traffic exh interference. | 21.6 | 67.9 | 12.5 | 163 |
| | 5-Aug-04 | 16:43 to 17:43 | Sample at NE corner of 52st and 120m east of 62ave. | 25.7 | 51.3 | 9.8 | 177 |
| | 6-Aug-04 | 18:01 to 19:01 | Sample 1/2 way between 50 & 51st on 59ave. ADM odours. | 22 | 67.2 | 6.2 | 234 |
| | 24-Nov-04 | 16:45 to 17:45 | Lots of road associated with odours | -1.1 | 68.5 | 17.4 | 169 |
| | 25-Nov-04 | 17:49 to 18:49 | Pick up ADM odours. | 2.9 | 76.2 | 12.6 | 273 |
| | 26-Nov-04 | 12:15 to 13:15 | Pick up ADM odours 600m east of main stack. | -2.2 | 75.7 | 7.9 | 287 |
| | 26-Nov-04 | 13:48 to 14:48 | Pick up odours. Also PR with lodge residents. | -0.9 | 80.8 | 12 | 288 |

**Table A8** **Weather Conditions and MAML Operator Remarks (Husky North Blackfoot Battery #2 and Little Dipper Used Oil Recovery Sites).**

| Site | Date | Time (MST) | Comments | Temperature | Relative Humidity | Wind Speed | Wind Direction |
|---|---|---|---|---|---|---|---|
| | | | | °C | % | km/h | degrees |
| Site 3 Husky North Blackfoot Battery #2 | 14-May-02 | 11:42 to 12:43 | Slight elevation from RHC 100m from dumping site. Elevated particulate from plant truck traffic | 20.8 | 25.9 | 22.4 | 104 |
| | 15-May-02 | 09:22 to 10:23 | Slight RHC 140m from plant. High particulate and light PAH from plant truck traffic | 7.9 | 48 | 13.4 | 79 |
| | 15-May-02 | 10:22 to 11:23 | High particulate from plant truck traffic | 10 | 39.3 | 13.4 | 88 |
| | 16-May-02 | 09:27 to 10:28 | No elevated readings | 14.6 | 22.9 | 6 | 158 |
| | 29-Jul-02 | 17:05 to 18:05 | North Batt #2 | 20 | 26.6 | 27.5 | 299 |
| | 7-Oct-02 | 17:22 to 18:22 | 1km south of facility on Rge Rd 20 | 4.9 | 66.4 | 11 | 323 |
| | 8-Oct-02 | 08:54 to 09:54 | Access road to wells on north side of facility. 15m from property fence line. Pick up odors. | 6.9 | 80 | 22 | 215 |
| | 8-Oct-02 | 09:54 to 10:54 | Access road to wells on north side of facility. 15m from property fence line. Pick up odors. | 7.8 | 78.4 | 18.8 | 211 |
| | 8-Oct-02 | 16:55 to 17:55 | Access road to wells on north side of facility. 15m from property fence line | 11.2 | 53.9 | 9.1 | 229 |
| | 18-Feb-04 | 13:07 to 14:07 | NW entrance 25m east of Rge Rd 20. Truck traffic (10-12 over 2 hrs) | 0.3 | 69.4 | 8.8 | 143 |
| | 18-Feb-04 | 14:07 to 15:07 | hydrocarbon odours from truck offloading. | 1.8 | 67.6 | 10.7 | 146 |
| | 20-May-04 | 08:24 to 09:24 | N entrance to facility. 162m W of storage tanks. Dust & PAH from truck traffic | 6.1 | 76.8 | 14.7 | 106 |
| | 20-May-04 | 09:24 to 10:24 | N entrance to facility. 162m W of storage tanks. Dust & PAH from truck traffic | 8.2 | 69.7 | 14.4 | 91 |
| | 20-May-04 | 15:51 to 16:51 | S end entrance to facility on Rge Rd 20. 51m from storage tanks. 105m from trucks. Truck dust. | 14.3 | 26.8 | 11 | 86 |
| | 4-Aug-04 | 12:34 to 13:34 | Sample at north entrance to facility. 25 trucks in first hour | 21.4 | 65.6 | 15.9 | 152 |
| | 4-Aug-04 | 13:34 to 14:34 | 10-12 trucks in second hour. All elevated data originates from trucks driving in and unloading product. | 23 | 57.5 | 25.3 | 148 |
| | 5-Aug-04 | 08:49 to 09:49 | Sample at north entrance on Rge Rd 20. 5 trucks lined up of offload Particulate and PAH from truck traffic | 19.6 | 74 | 6.3 | 194 |
| | 24-Nov-04 | 14:17 to 15:17 | Road dust from truck traffic | -1.3 | 68.3 | 11.7 | 173 |
| Site 4 Little Dipper Used Oil Recovery | 14-May-02 | 13:29 to 14:30 | No activity from recycle facility | 20.9 | 23.8 | 24.2 | 55 |
| | 15-May-02 | 09:05 to 09:06 | No elevated readings. No activity at site | 5.5 | 62.1 | 12.2 | 52 |
| | 15-May-02 | 15:45 to 16:46 | No elevated readings and no activity from recycle plant | 16 | 18.1 | 8 | 114 |
| | 16-May-02 | 08:04 to 09:05 | No elevated readings | 13.6 | 31.3 | 7.7 | 174 |
| | 30-Jul-02 | 13:51 to 14:51 | Little Dipper | 22.5 | 23.6 | 15.6 | 286 |
| | 7-Oct-02 | 16:02 to 17:02 | 84m south of facility at entrance | 8.6 | 56.6 | 13.2 | 248 |
| | 19-Feb-04 | 12:15 to 13:15 | stop 100m east and a little south of facility. No odours | 4 | 65.5 | 12 | 280 |
| | 19-Feb-04 | 16:06 to 17:06 | stop 100m east and a little south of facility. No odours | 3.1 | 73.9 | 9.6 | 295 |
| | 19-May-04 | 12:31 to 13:31 | 102m SW of facility. Interference from vehicle emissions | 19 | 22.9 | 17.6 | 158 |
| | 19-May-04 | 16:07 to 17:07 | 102m SW of facility. Exh and Particulate from backhoe operating 70m N of MAML | 19.4 | 21.1 | 12.7 | 47 |
| | 5-Aug-04 | 15:35 to 16:35 | Sample 402m directly north of facility on a well service road. | 26 | 53 | 6.6 | 169 |
| | 25-Nov-04 | 13:14 to 14:14 | Diesel truck traffic. | 2.6 | 68 | 19 | 317 |
| | 25-Nov-04 | 14:14 to 15:14 | Diesel truck traffic | 2 | 66.3 | 15.9 | 310 |

**Table A9 Weather Conditions and MAML Operator Remarks (Husky Oil Refinery Site).**

| Site | Date | Time (MST) | Comments | Temperature | Relative Humidity | Wind Speed | Wind Direction |
|---|---|---|---|---|---|---|---|
| | | | | °C | % | km/h | degrees |
| 5 Husky Oil Refinery | 14-May-02 | 14:42 to 15:43 | No elevated readings | 20.7 | 22.6 | 26.4 | 75 |
| | 14-May-02 | 16:06 to 17:07 | Slight TRS & H2S near gate entrance on 52 St South side of plant | 18.9 | 24.8 | 25.6 | 59 |
| | 15-May-02 | 18:00 to 19:01 | 59 Ave. and 52 St. Downwind of plant. Light odors. Particulate & PAH from local traffic. | 14.1 | 19.9 | 7 | 70 |
| | 16-May-02 | 12:18 to 13:19 | No elevated readings | 17.7 | 18.7 | 9.2 | 171 |
| | 29-Jul-02 | 13:12 to 14:12 | None | 20.3 | 33.7 | 23.4 | 249 |
| | 29-Jul-02 | 14:12 to 15:12 | None | 21.6 | 25.6 | 21.8 | 267 |
| | 30-Jul-02 | 11:31 to 12:31 | None | 17.6 | 33.3 | 13.2 | 288 |
| | 30-Jul-02 | 12:31 to 13:31 | None | 20.7 | 29.6 | 13.6 | 301 |
| | 30-Jul-02 | 15:08 to 16:08 | None | 22 | 23.8 | 21 | 311 |
| | 30-Jul-02 | 17:35 to 18:35 | None | 21.1 | 27.9 | 22.5 | 303 |
| | 31-Jul-02 | 07:49 to 08:49 | None | 9.5 | 68.9 | 27.6 | 290 |
| | 31-Jul-02 | 10:50 to 11:50 | None | 12.4 | 62.9 | 22.3 | 299 |
| | 7-Oct-02 | 13:39 to 14:39 | 52 st 130m west of 52 ave. Heavy condensate odors | 9.6 | 67.2 | 21.7 | 277 |
| | 7-Oct-02 | 14:46 to 15:46 | 52 st 100m west of 55 ave. Pick up odors. | 10.1 | 55.8 | 21.2 | 214 |
| | 8-Oct-02 | 15:19 to 16:19 | 50 ave and 61 st. Behind Husky gas stn and car wash. Pick up odors. | 15.3 | 38.3 | 20.7 | 235 |
| | 9-Oct-02 | 10:06 to 11:06 | Entrance to Lloydminster Estates. 448m from stack. Canister (ser# 1934) grab (<1 min ) sample taken. | 15.4 | 35.2 | 10.5 | 246 |
| | 26-Feb-03 | 14:50 to 15:50 | Sitting 196m from nearest stack and 40m from railcars. | -2.9 | 58.9 | 6.2 | 264 |
| | 27-Feb-03 | 09:01 to 10:01 | Pick up odors from refinery. | -9.2 | 85.2 | 13.2 | 217 |
| | 27-Feb-03 | 10:38 to 11:38 | Husky odors. | -6.6 | 81.9 | 9.2 | 265 |
| | 27-Feb-03 | 15:44 to 16:44 | Downwind of Husky | -4.8 | 85.1 | 6 | 296 |
| | 27-Feb-03 | 16:59 to 17:59 | Pick up very light odors from refinery. | -5.2 | 87.1 | 4.9 | 244 |
| | 28-Feb-03 | 09:15 to 10:15 | Very light odors detected | -10 | 86 | 2.8 | 275 |
| | 18-Feb-04 | 16:43 to 17:43 | 59 Ave and 750m north of 52 St. 617m NW of main stack. Light HC odours | -1.4 | 85.3 | 12 | 128 |
| | 18-Feb-04 | 18:01 to 19:01 | 59 Ave 150m south of 62 St. Light HC odours | -2.6 | 90.3 | 13.2 | 121 |
| | 19-Feb-04 | 08:44 to 09:44 | NE end of Greif property. 169m east of Procor rail cars and 307m from storage containers | -0.4 | 68.2 | 17.1 | 280 |
| | 19-Feb-04 | 17:23 to 18:23 | NE end of Greif property. 169m east of Procor rail cars and 307m from storage containers | 1.2 | 60.8 | 14.6 | 274 |
| | 19-Feb-04 | 18:23 to 19:23 | NE end of Greif property. 169m east of Procor rail cars and 307m from storage containers | 0.5 | 62.8 | 13.8 | 275 |
| | 20-Feb-04 | 08:42 to 09:42 | NE end of Greif property. 169m east of Procor rail cars and 307m from storage containers | 0.5 | 72 | 14.8 | 282 |
| | 19-May-04 | 13:48 to 14:48 | 52st and 53ave , downwind of facility. Interference from vehicle emissions | 20.9 | 20.6 | 12 | 133 |
| | 20-May-04 | 12:15 to 13:15 | W side of Husky 436m NW of large stack. THC odours. Traffic road dust | 12.7 | 44.4 | 10 | 70 |
| | 20-May-04 | 13:15 to 14:15 | W side of Husky 436m NW of large stack. THC odours. Traffic road dust. | 11.9 | 46.5 | 11.1 | 65 |
| | 21-May-04 | 08:10 to 09:10 | SW corner of Husky at 52st. 286m east of 59ave. 196m from stack. Odours form Husky. Dust from fields | 10.6 | 28.9 | 11.8 | 82 |
| | 4-Aug-04 | 16:11 to 17:11 | Sample at 59 ave and 57 st. Light THC odours. 489m NW of main stack. Particulate and PAH readings are from local truck traffic | 22 | 55.2 | 30.9 | 140 |
| | 5-Aug-04 | 11:43 to 12:43 | Sample at 59 ave and 57 st. Light THC odours. 489m NW of main stack. | 23.2 | 61.6 | 10.8 | 165 |
| | 5-Aug-04 | 12:58 to 13:58 | Sample at #138 Heritage Estates. | 25.3 | 56.4 | 8.6 | 172 |
| | 6-Aug-04 | 10:04 to 11:04 | H2S from Husky; likely from the rail cars which are 186m west of MAML | 20.7 | 71.1 | 13.3 | 255 |
| | 24-Nov-04 | 15:36 to 16:36 | None | -1.2 | 73.1 | 12.9 | 171 |
| | 24-Nov-04 | 16:56 to 17:56 | Some diesel exhaust during hour | -1.2 | 77.5 | 11.3 | 162 |
| | 24-Nov-04 | 17:56 to 18:56 | None | -0.9 | 78.2 | 12.8 | 197 |
| | 25-Nov-04 | 08:49 to 09:49 | Odours and H2S from Husky | 2 | 85.2 | 13.7 | 204 |